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ABSTRACT

This report presents ten recommendations for the radical reconstruction of undergraduate education at research universities in the United States offered by a national commission. Background information is provided in the first three chapters. An overview notes that undergraduates at research universities too often have been shortchanged and that a new model of undergraduate education is needed. Discussion of the university as ecosystem stresses the importance of a shared mission and a synergistic system in which faculty and students are both learners and researchers. An academic bill of rights for students is offered. The main body of the report presents and explains the commission's ten recommendations, which are: (1) make research-based learning the standard; (2) construct an inquiry-based freshman year; (3) build on the freshman foundation; (4) remove barriers to interdisciplinary education; (5) link communication skills and course work; (6) use information technology creatively; (7) culminate with a capstone experience; (8) educate graduate students as apprentice teachers; (9) change faculty reward systems; and (10) cultivate a sense of community. Appendices provide lists of Carnegie classified research universities and the members of the Boyer Commission. (DB)

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ED 424 840

The Boyer Commission
on Educating Undergraduates
in the Research University

REINVENTING UNDERGRADUATE EDUCATION:

A Blueprint for America's Research Universities

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Reinventing Undergraduate Education

The Boyer Commission
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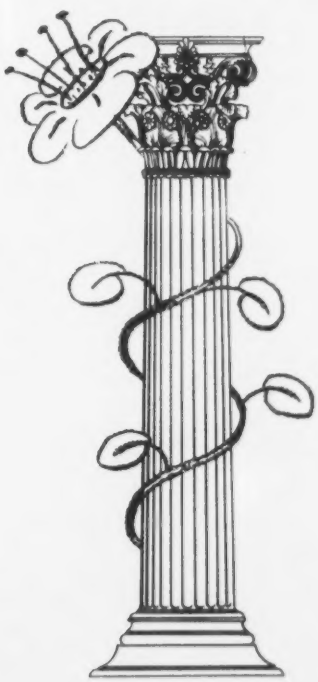
REINVENTING UNDERGRADUATE EDUCATION:

A Blueprint for America's Research Universities



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This report is dedicated to the memory of Ernest L. Boyer, President of the Carnegie Foundation for the Advancement of Teaching until his death in December, 1995, and formerly Chancellor of the State University of New York and U.S. Commissioner of Education. During a lifetime of enthusiastic and thoughtful commitment to American higher education, he exhorted, advised, inspired, and invigorated a generation of academic leaders. His career was an extended exploration of what it means to be an educated person and how real education is attained. This report is an effort to continue examining the themes to which he brought so much.

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of the Boyer Commission on Educating Undergraduates in the Research University

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We are most grateful to Robert W. Kenny, who wrote the report, and Milton Glaser, who designed it.

Our work was influenced by outstanding researchers/educators, most particularly Jaroslav Pelikan, Sterling Professor Emeritus of History at Yale University and President of the American Academy of Arts and Sciences, who met with the Commission on several occasions. For their advice and critiques we thank Robert Diamond, Assistant Vice Chancellor for Instructional Development at Syracuse University; Billy E. Frye, Chancellor of Emory University; Stan Katz, past president of the American Council of Learned Societies; Mary Huber, Senior Scholar at the Carnegie Foundation; and James Lightbourne, Science Advisor to the National Science Foundation's Division of Undergraduate Education.

Mary Leming, Graduate Assistant at Stony Brook University, furnished invaluable staffing for the project. Emily Thomas provided research data, and Victoria Katz and Yvette St. Jacques helped with final editing.

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TABLE OF CONTENTS

Preface 1

An Overview 5

The University as Ecosystem 9

An Academic Bill of Rights 12

Ten Ways to Change Undergraduate Education 14

I. Make Research-Based Learning the Standard 15

II. Construct an Inquiry-based Freshman Year 19

III. Build on the Freshman Foundation 21

IV. Remove Barriers to Interdisciplinary Education 23

V. Link Communication Skills and Course Work 24

VI. Use Information Technology Creatively 25

VII. Culminate with a Capstone Experience 27

VIII. Educate Graduate Students as Apprentice Teachers . . . 28

IX. Change Faculty Reward Systems 31

X. Cultivate a Sense of Community 34

Conclusion 37

Appendices

A. American Research Universities 39

B. Membership of the Boyer Commission 41

PREFACE

The National Commission on Educating Undergraduates in the Research University was created in 1995 under the auspices of the Carnegie Foundation for the Advancement of Teaching. It met for the first time July 27, 1995, at the headquarters of the Carnegie Foundation in Princeton, New Jersey, with Ernest L. Boyer, President of the Foundation, presiding.

Dr. Boyer set the tone for the deliberations by reminding the Commission that conditions in higher education have changed significantly in recent years: the American system of higher education has become less elite; students (and parents) have developed their own, often vigorously asserted, ideas about education and credentialing rather than accepting traditional modes without question; a much greater range of undergraduate professional degrees has become available; the freshman year has too often been reduced to remediation or repetition of high school curriculum, rather than an introduction to a new and broader arena for learning. Recognition of those and other changes would form a starting point for the Commission's deliberations.

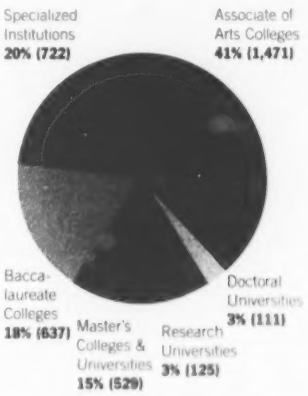
Dr. Boyer died at the time of the second meeting, on December 8, 1995, and with his passing, the Commissioners felt impoverished by the loss of his overarching intelligence and perceptiveness about American education, and at the same time determined to produce a report reflective of his commitment to these issues. The Commission was renamed in his memory.

This report does not enter the continuing discussion of the content of the undergraduate curriculum—whether there should be more science, more mathematics, more foreign language, more anything—and it does not address the issue that has come to be labeled 'The Canon,' the body of writings deemed to be the requisite possession of the educated person. Those matters concern every institution involved in baccalaureate education. But research universities share a special set of characteristics and experience a range of common challenges in relation to their undergraduate students. If those challenges are not met, undergraduates can be denied the kind of education they have a right to expect at a research university, an education that, while providing the essential features of general education, also introduces them to inquiry-based learning.

The recommendations urged in this report will be controversial; some administrators and faculty will protest that they are unreachable or impractical, or that the goals entertained can be achieved by minor adjustments of existing practice. We realize

THE FACTS

Universe of Institutions by Carnegie Classifications, 1994



Percentage of all undergraduates who graduate from Research I & II Universities: **32%**

Research Universities as a percentage of all bachelor's-degree-granting institutions: **6%**

Research Universities as a percentage of all higher education institutions: **3%**

Source: Carnegie Classification 1994, including data from the U.S. Department of Education's Integrated Postsecondary Education Data System (IPEDS).

that not everything in this report is applicable to all research universities, but we hope these recommendations will stimulate new debate about the nature of undergraduate education in research universities that will produce widespread and sweeping reform.

What is a Research University?

THE UNITED STATES HAS MORE THAN 3,500 INSTITUTIONS OF HIGHER education. More than two thousand of them offer only Associate or Bachelor degrees. Of the remainder, the Carnegie Foundation for the Advancement of Teaching in 1994 classified eighty-eight as "Research I" universities; they are those which "offer a full range of baccalaureate programs, are committed to graduate education through the doctorate, and give high priority to research. They award 50 or more doctoral degrees each year. In addition, they receive annually $40-million or more in federal support." An additional thirty-seven institutions are called "Research II" universities: they receive "between $15.5-million and $40-million" in federal support but are otherwise like the Research I universities. A list of the Research I and Research II universities is appended to this report.

Significantly, almost all the Nobel laureates who have identified themselves as professors have been affiliated with research universities.

Because of the research universities' commitment to create new knowledge, they consider research capability as a primary qualification for appointment, promotion, and tenure of faculty members, and they pride themselves on having world-class scholars among their ranks. Significantly, almost all the Nobel laureates who have identified themselves as professors have been affiliated with research universities. Of course, outstanding researchers are not limited to these institutions; nearly all colleges and universities can point to strong scholars within their departments. But at research universities, these faculty become a defining element. Research universities also have graduate students and post-doctoral fellows in far greater numbers than other institutions, since graduate education is a major component of their mission. Another characteristic is the requisite research environment, including extensive libraries, well-equipped laboratories, sophisticated computer capabilities, and, often, university presses, all housed in appropriate facilities.

Research universities characteristically have an international orientation. They attract students, particularly at the graduate level, from many parts of the world, thereby adding valued dimensions of diversity to the community. The international graduate students often become teaching assistants, so their presence becomes a part of undergraduate experience. And many research universities offer an array of interdisciplinary programs seldom available in smaller institutions. The graduates of these programs enter diplomatic service and international journalism, banking, commerce, and technology. They help to make the names of the American research universities recognized and respected throughout the world.

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In American higher education, nearly every institution has held racial and ethnic diversity to be a desirable goal. It is widely recognized that meaningful association with Americans of varying

backgrounds and cultural histories, as well as contact with international students, adds to the breadth of baccalaureate experience and may serve long-range social goals of diversity and racial accommodation. Research universities have made diligent and often successful efforts to attract and hold students from racial and ethnic minorities. The large public universities with their lower tuition rates can promise education and social mobility to numbers of students from lower-income families of all kinds, and the well-endowed private universities can offer financial support, often quite generous, to gifted students of every background. So the campuses of research universities are characteristically heterogeneous places, polyglot, multi-cultural, and multi-ethnic.

Most if not all research universities have also recognized a special role in visual and performing arts. After students learn to use the materials of the discipline, students in the arts are engaged in independent research throughout their programs, for every exercise in painting, photography, musical composition or performance is a problem to be solved as surely as a problem in physics. Adjunct to their academic programs, universities support a range of public arts programs, often housed in facilities that rival the best in major cities. These programs can be the principal components of the cultural life of their neighborhoods or their regions; their communities as well as their students are the beneficiaries.

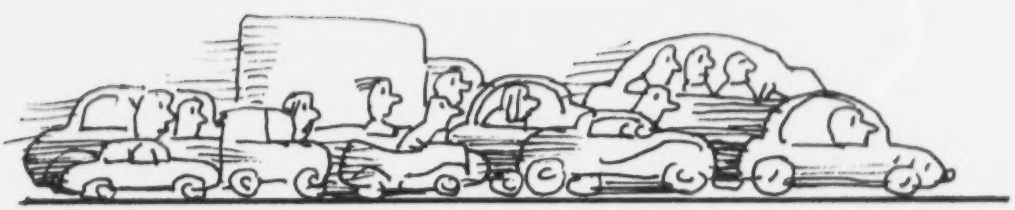
Most if not all research universities have recognized a special role in visual and performing arts.

Differences within research universities are as striking as commonalities. Most obviously, size varies within wide limits. Public and private institutions differ so significantly in governance and funding arrangements that they provide very different learning contexts. At private research universities, from four-fifths to nine-tenths of freshmen will graduate from the same university within five years; at public institutions, the number will be closer to two-thirds. In California, large numbers of students spend their first two years at community colleges before transferring to the public research campus from which they will graduate; that pattern is not uncommon in other states. Many public research universities enroll huge numbers of working students whose graduations are delayed well beyond five years. As a result, developing a continuum in curriculum from freshman through senior years is far more difficult at many public institutions. Students at public universities are also more likely to come from within the state and are more likely to commute to classes than their counterparts at the private institutions.

The character of a research university is strongly influenced by its setting. Some, such as Cornell or the University of North Carolina at Chapel Hill, dominate the small cities where they grew up; others, such as the University of Pennsylvania or Columbia University, take on the qualities of their metropolitan settings. Some, such as Princeton or Rice, have almost wholly residential populations; at others, such as the University of Maryland at College Park or the University of Texas at Austin, the majority of students, whether local residents or not, live outside the immediate campus.

The Commission recognizes the pitfalls of generalizing about a group of institutions so varied as the research universities of the United States. Every research university in the country could truthfully say that some or many of the negative characteristics described in this report are not accurate for that institution. Every institution would claim to take undergraduate education seriously; the well-financed private institutions can no doubt make that claim with greatest success. None, however, could demonstrate that it has solved fully the problems we are assessing here. Some, particularly large public institutions, believe they do not have the resources they need to customize baccalaureate education. Some of these institutions have ancient roots; others are latecomers, bootstrapping their way into the company of far better endowed universities. But the Commission believes that the problems of undergraduate education are common to them all.

None of this is to suggest that one kind of university is superior to another. Research universities are all complex institutions, cities in themselves, with diverse, sometimes internally conflicting goals and interests. They pose challenges to the student who seeks to explore their geography, intellectual as well as physical. The potential rewards of that exploration are almost limitless; the challenge to the universities is to make the exploration not only possible but easily accessible.



Some universities, like Princeton or Rice, have almost wholly residential populations; others, like Temple or Rutgers, have large numbers of commuters.

REINVENTING UNDERGRADUATE EDUCATION

A Blueprint for America's Research Universities

An Overview

In a great many ways the higher education system of the United States is the most remarkable in the world. The speed with which it developed, its record of achievement, the extent of its reach, the range of its offerings are without parallel. And, particularly in the years since World War II, the system has reached a higher proportion of the national population than that of any other country. Half of the high school graduates in the United States now gain some experience in colleges and universities; we are, as a country, attempting to create an educated population on a scale never known before. The goal of President Harry Truman's 1947 Commission on Higher Education, that the system must provide "the means by which every citizen, youth, and adult, is enabled and encouraged to carry his education, formal and informal, as far as his native capacities permit" is accepted as axiomatic.

In the higher education system in the United States, the research universities have played a leading role: the country's 125 research universities make up only 3 per cent of the total number of institutions of higher learning, yet they confer 32 per cent of the baccalaureate degrees, and 56 per cent of the baccalaureates earned by recent recipients of science and engineering doctorates (1991-95). Their graduates fill the legislatures and board rooms of the country, write the books we read, treat our ailments, litigate our issues, develop our new technologies, and provide our entertainment. To an overwhelming degree, they have furnished the cultural, intellectual, economic, and political leadership of the nation.

Undergraduates Too Often Shortchanged in the Past

NEVERTHELESS, THE RESEARCH UNIVERSITIES HAVE TOO OFTEN failed, and continue to fail, their undergraduate populations. Tuition income from undergraduates is one of the major sources of university income, helping to support research programs and graduate education, but the students paying the tuition get, in all too many cases, less than their money's worth. An undergraduate at an American research university can receive an education as good or better than anything available anywhere in the world, but that is not the normative experience. Again and again, universities are guilty of an advertising practice they would condemn in the commercial world. Recruitment materials display proudly the world-famous professors, the splendid facilities and the ground-breaking research that goes on within them, but thousands of students graduate without ever seeing the world-famous professors

THE FACTS

University-level education rates in the United States and abroad

This table indicates the percentage of the population of selected nations that enters college or university; it does not have graduation rates.

Net entry to post-secondary university/college education, for people ages 15 and over:

United States	**52%**
Canada	**49%**
United Kingdom	**43%**
New Zealand	**40%**
Netherlands	**34%**
France	**33%**
Denmark	**31%**
Germany	**27%**
Ireland	**27%**
Austria	**26%**
Norway	**25%**
Hungary	**20%**
Turkey	**16%**
Switzerland	**15%**
Average	**30%**

Source: Organization for Economic Cooperation and Development (OECD) Database, Table C4.2, Net Entry rates for university-level education (1995).

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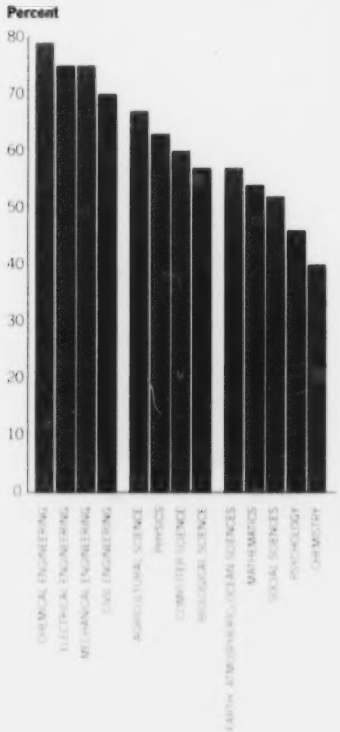
THE FACTS

Percentage of recent science and engineering doctoral recipients who earned their bachelor's degrees at U.S. research universities, by field of doctorate.



Source: National Science Foundation SRS Survey of Earned Doctorates for the years 1991-95

or tasting genuine research. Some of their instructors are likely to be badly trained or even untrained teaching assistants who are groping their way toward a teaching technique; some others may be tenured drones who deliver set lectures from yellowed notes, making no effort to engage the bored minds of the students in front of them.

Many students graduate having accumulated whatever number of courses is required, but still lacking a coherent body of knowledge or any inkling as to how one sort of information might relate to others. And all too often they graduate without knowing how to think logically, write clearly, or speak coherently. The university has given them too little that will be of real value beyond a credential that will help them get their first jobs. And with larger and larger numbers of their peers holding the same paper in their hands, even that credential has lost much of its potency.

These are not problems that have been totally denied or ignored; there is probably no research university in the country that has not appointed faculty committees and created study groups or hired consultants to address the needs of its undergraduates. There have been results: new courses, new majors, revised curricula. A new study by the Center for Instructional Development at Syracuse University suggests that universities believe they are now giving more attention to teaching. At a sample of eleven research universities, deans, department heads, and other administrators said more emphasis was being given to teaching than five years ago.

Radical Reconstruction

EVEN SO, FOR THE MOST PART FUNDAMENTAL CHANGE HAS BEEN shunned; universities have opted for cosmetic surgery, taking a nip here and a tuck there, when radical reconstruction is called for. Serious responses to complaints about undergraduate teaching have generated original and creative pedagogical and curricular experiments. But too often bold and promising efforts have vanished after external grant support disappeared, have withered on the fringes of the curriculum, or have been so compromised that their originality has been lost. Strikingly, the Syracuse study reported that research productivity was still given "much more" weight in making decisions about promotion and tenure of faculty members than was teaching effectiveness.

The way the research university developed made the present-day situation predictable if not inevitable. The inspiration was the German universities of the nineteenth century, which had redefined themselves as institutions dedicated to advanced research on scientific principles. America's leading colleges adopted parallel goals and began giving advanced degrees, finding honor, excitement, and reward in the exploration of intellectual frontiers made by their faculties. In a country and an era fascinated with discovery and expansion, the research mission has overshadowed the earlier collegiate function of training young men to be ministers, lawyers, and gentlemen. The older function had to be maintained, but the undergraduate experience given the young men, and later

the young women as well, was kept isolated from the research activity and still cast in the pre-university mold. Universities on the whole did not see ways to integrate their undergraduates into the research missions that they valued above all else. As Ernest Boyer said in his *Scholarship Reconsidered* in 1990, "the focus had moved from the student to the professoriate, from general to specialized education, from loyalty to the campus to loyalty to the profession." Advanced research and undergraduate teaching have existed on two quite different planes, the first a source of pleasure, recognition, and reward, and the latter a burden shouldered more or less reluctantly to maintain the viability of the institution.

Defining Worth

THE PRIMACY OF RESEARCH WITHIN THE ESPOUSED MISSIONS OF American universities is attested over and over within the academic world. The standing of a university is measured by the research productivity of its faculty; the place of a department within the university is determined by whether its members garner more or fewer research dollars and publish more or less noteworthy research than other departments; the stature of the individual within the department is judged by the quantity and quality of the scholarship produced. Every research university can point with pride to the able teachers within its ranks, but it is in research grants, books, articles, papers, and citations that every university defines its true worth. When students are considered, it is the graduate students that really matter; they are essential as research assistants on faculty projects, and their placement as post-doctoral fellows and new faculty reinforces the standing of the faculty that trained them. Universities take great pleasure in proclaiming how many of their undergraduates win Rhodes or other prestigious scholarships and how many are accepted at the most selective graduate schools, but while those achievements are lauded, too many students are left alone to pursue them. And the baccalaureate students who are not in the running for any kind of distinction may get little or no attention.

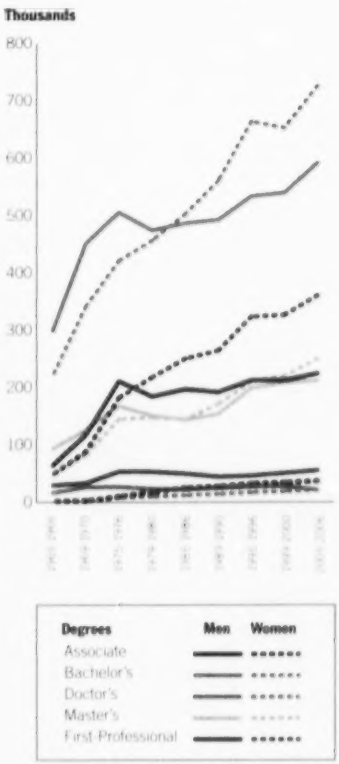
Why, then, should baccalaureate students give their loyalty and their money to research universities? Because the potential remains for acquiring a virtually matchless education. The research universities possess unparalleled wealth in intellectual power and resources; their challenge is to make their baccalaureate students sharers of the wealth. To realize their potential means a complete transformation in the nature of the education offered.

A New Model

WHAT IS NEEDED NOW IS A NEW MODEL OF UNDERGRADUATE education at research universities that makes the baccalaureate experience an inseparable part of an integrated whole. Universities need to take advantage of the immense resources of their graduate and research programs to strengthen the quality of undergraduate education, rather than striving to replicate the special environment of the liberal arts colleges. There needs to be a symbiotic relationship between all the participants in university learning that will provide a new kind of undergraduate experience

THE FACTS

Earned degrees by level and sex, 1969-70 to 2005-06



Note: 1995-1996, 1999-2000, and 2005-2006 data is projected.

Source: U.S. Department of Education, National Center for Education Statistics, Earned Degrees Conferred; Projections of Education Statistics to 2006; and Integrated Postsecondary Education Data System (IPEDS), "Completions" surveys. This information was prepared February 1996.

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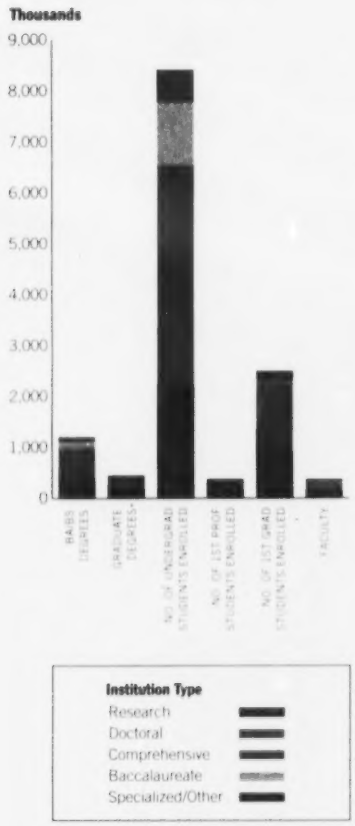
THE FACTS

Where students go for higher education

Excluding Two-Year Colleges



*Includes Masters and Ph.D. Excludes First Professional due to bad data. Excludes certificates

Source: 1994 IPEDS

available *only* at research institutions. Moreover, productive research faculties might find new stimulation and new creativity in contact with bright, imaginative, and eager baccalaureate students, and graduate students would benefit from integrating their research and teaching experiences. Research universities are distinctly different from small colleges, and they need to offer an experience that is a clear alternative to the college experience.

It is obvious that not every student should, or would wish to, attend a research university. Without attempting to characterize students at other kinds of institutions, it might be said that the undergraduate who flourishes at a research university is the individual who enjoys diverse experiences, is not dismayed by complexity or size, has a degree of independence and self-reliance, and seeks stimulation more than security. A research university is in many important ways a city; it offers almost unlimited opportunities and attractions in terms of associations, activities, and enterprises. But as in a city, the requirements of daily living may be taxing, and sorting out the opportunities and finding like-minded individuals may be difficult. The rewards of the ultimate experience, however, can be immeasurable.

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THE UNIVERSITY AS ECOSYSTEM

Albert Einstein once articulated what many scholars have felt in their own work:

The history of scientific and technical discovery teaches us the human race is poor in independent thinking and creative imagination. Even when the external and scientific requirements for the birth of an idea have long been there, it generally needs an external stimulus to make it actually happen; man has, so to speak, to stumble right up against the thing before the right idea comes.

The birth of an idea generally needs an external stimulus to make it actually happen.

Research universities provide the context in which the external stimuli operate with the greatest effectiveness, in which stumbling against the thing should happen with the greatest ease and frequency. The interaction of many kinds of stimuli creates at a university a special kind of intellectual environment, with the health of the whole a manifestation of the health of each part. That environment should become an intellectual ecosystem. Universities are communities of learners, whether those learners are astrophysicists examining matter in the far reaches of space or freshmen new to an expanded universe of learning. The shared goals of investigation and discovery should bind together the disparate elements to create a sense of wholeness.

Searching for a Shared Mission

THE ECOLOGY OF THE UNIVERSITY DEPENDS ON A DEEP AND abiding understanding that inquiry, investigation, and discovery are the heart of the enterprise, whether in funded research projects or in undergraduate classrooms or graduate apprenticeships. Everyone at a university should be a discoverer, a learner. That shared mission binds together all that happens on a campus. The teaching responsibility of the university is to make all its students participants in the mission. Those students must undergird their engagement in research with the strong "general" education that creates a unity with their peers, their professors, and the rest of society.

Unfortunately, research universities are often archipelagos of intellectual pursuit rather than connected and integrated communities. Fragmentation has increased drastically during the last fifty years. At many universities, research faculty and undergraduate students do not expect to interact with each other, and both groups distinguish between teachers and researchers as though the two experiences were not inextricably linked. Even those students who encounter an introduction to research

technique in one narrow field too often remain ignorant of how diverse fields overlap and intermingle.

The institutional goal of research universities should be a balanced system in which each scholar—faculty member or student—learns in a campus environment that nurtures exploration and creativity on the part of every member.

A Beautiful and Efficient Concept

IDEALLY, THE CAMPUS ENVIRONMENT IS ENRICHED BY INTERACTION among faculty members in disparate fields, with graduate students enlivened by their exploration of faculty roles, and with undergraduates, whose questions and fresh approaches may open new paths of inquiry. The faculty member, unlike the full-time non-academic researcher, has interactions with other faculty and with students that broaden his or her intellectual vista and simultaneously provide the opportunity to develop future generations of professors and researchers. The baccalaureate student shares in the environment and develops his or her own research capabilities. The university setting for research is, therefore, much more valuable to our society than the environment in corporate or non-profit research laboratories and institutes. As Charles M. Vest, President of the Massachusetts Institute of Technology, has pointed out, government funding of research in the universities is also an investment in the education of the next generation, with every dollar doing double duty, "a beautiful and efficient concept." What is more, the university's investment in research faculty also does double duty, with teaching ideally enhanced by the research experience of both faculty and students.

Teaching Teachers to Teach

IN CONTRAST TO THIS IDEAL, THERE IS NOW A DISTRESSING AND, in the long run, a destructive lack of connection between undergraduate study and the creation of future research faculty. The use of graduate students, particularly in certain fields, has been treated as a necessity for the operation of both research programs and undergraduate instruction. This perceived need has often led to the importation of foreign students new to American education. The international graduate students have been and must be welcomed in our universities; they have added incalculable strengths to research programs and, after graduation, to university faculties and research institutes. But the classroom results of employing teaching assistants who speak English poorly, as a second language, and who are new to the American system of education constitute one of the conspicuous problems of undergraduate education. Unless fully proficient speakers of English are attracted to the professoriate in the United States, these problems will continue to exist. Research universities have, therefore, a strong interest in introducing research-based education to undergraduates who are proficient in English in the hope that many of those research-trained undergraduates will be drawn toward academic careers. Joined by the bright and eager international students, they will furnish unprecedented pools of talent from which future faculties will be drawn.

Needed Now: a Synergistic System

UNDERGRADUATES WHO ENTER RESEARCH UNIVERSITIES SHOULD understand the unique quality of the institutions and the concomitant opportunities to enter a world of discovery in which they are active participants, not passive receivers. Although shared knowledge is an important component of a university education, no simple formula of courses can serve all students in our time. Collaborative learning experiences provide alternative means to share in the learning experiences, as do the multitudinous resources available through the computer. The skills of analysis, evaluation, and synthesis will become the hallmarks of a good education, just as absorption of a body of knowledge once was.

The phrase "student-centered research university" has sprung into the language of several research universities recently. At first glance it seems an oxymoron, and certainly it does not clearly describe the relationship between students and research—can universities be both student-centered and research-centered? The possibility exists that a "research university," properly defined, could embody what the phrase attempts, through a synergistic system in which faculty and students are learners and researchers, whose interactions make for a healthy and flourishing intellectual atmosphere.

AN ACADEMIC BILL OF RIGHTS

When a university accepts an undergraduate student for admission and the student then enrolls, implicit commitments constitute an unwritten contract between them. Each assumes obligations and responsibilities, and each receives benefits. The student commits to a course of study intended to lead to a degree, agrees to follow such rules of civil behavior as the university prescribes, accepts the challenge of making an appropriate contribution to the community of scholars, and pledges to cultivate her or his mind, abilities, and talents with a view to becoming a productive and responsible citizen. The student at a research university, in addition, must come with appropriate preparation for the opportunities that will be provided, must commit to the strenuous burdens of active participation in the educational process, and must be prepared to live in a diverse and heterogeneous environment.

By admitting a student, any college or university commits itself to provide maximal opportunities for intellectual and creative development. These should include:

1. Opportunities to learn through inquiry rather than simple transmission of knowledge.
2. Training in the skills necessary for oral and written communication at a level that will serve the student both within the university and in postgraduate professional and personal life.
3. Appreciation of arts, humanities, sciences, and social sciences, and the opportunity to experience them at any intensity and depth the student can accommodate.
4. Careful and comprehensive preparation for whatever may lie beyond graduation, whether it be graduate school, professional school, or first professional position.

The student in a research university, however, has these additional rights:

1. Expectation of and opportunity for work with talented senior researchers to help and guide the student's efforts.
2. Access to first-class facilities in which to pursue research—laboratories, libraries, studios, computer systems, and concert halls.
3. Many options among fields of study and directions to move within those fields, including areas and choices not found in other kinds of institutions.

4. Opportunities to interact with people of backgrounds, cultures, and experiences different from the student's own and with pursuers of knowledge at every level of accomplishment, from freshmen students to senior research faculty.

The research university must facilitate inquiry in such contexts as the library, the laboratory, the computer, and the studio, with the expectation that senior learners, that is, professors, will be students' companions and guides. The research university owes every student an integrated educational experience in which the totality is deeper and more comprehensive than can be measured by earned credits.

The research university's ability to create such an integrated education will produce a particular kind of individual, one equipped with a spirit of inquiry and a zest for problem solving; one possessed of the skill in communication that is the hallmark of clear thinking as well as mastery of language; one informed by a rich and diverse experience. It is that kind of individual that will provide the scientific, technological, academic, political, and creative leadership for the next century.

TEN WAYS TO CHANGE UNDERGRADUATE EDUCATION

SIGNS OF CHANGE

University Case Study
Undergraduate
Research Opportunities

University
Massachusetts Institute of Technology

More than half of all undergraduates at the Massachusetts Institute of Technology take part in the Undergraduate Research Opportunities Program, in which students may work with faculty members or on independent projects. Interested students submit written proposals and are interviewed by the professors leading the projects chosen; the program helps students who propose their own projects find faculty sponsorship. Students may receive either hourly wages or academic credit. The UROP Research Mentor Program links students just beginning on a project with experienced students. The Undergraduate Research Apprentice Program in science and engineering at the University of California Berkeley, and other universities similarly provides opportunities for undergraduate research.

This concept of integrated education requires restructuring both the pedagogical and the integrative aspects of the research university experience. The Boyer Commission recommends the goals that follow in order to meet the obligations of the university to all students, as expressed in the Academic Bill of Rights.

One caveat: we believe that research universities must be willing and able to break free from the traditions that have thus far governed budget creation and budget approval in order to think creatively about goals and techniques for reaching those goals.

Redirecting Resources

UNIVERSITY BUDGETS ARE NOW BASED ON THE PRINCIPLE OF departmental hegemony; as a result, important innovations such as new approaches through interdisciplinarity are often doomed for lack of departmental sponsorship. Departments necessarily think in terms of protecting and advancing their own interests, defined in terms of numbers of faculty, courses, and majors. Initiatives for change coming from sources outside departments are viewed as threats rather than opportunities. New decisions on distributing resources must be carried out at the highest levels in the university, and they can be expected to meet little enthusiasm from those whose interests are protected by existing systems.

Academics have long believed that research universities require large lecture sections combined with study sections run by teaching assistants in order to teach many lower division courses. Yet technology will unquestionably change the nature of pedagogy. We believe that faculty time is best invested in classes in which interaction with students is normal and integral. Used creatively, electronic communication techniques can also be uniquely effective for certain kinds of courses, for example, some of those that have been taught in large lecture sections. Students are able to fit course materials into their own schedules and repeat material as often as desired. Technology provides an alternative context for learning, a context universities need to use. It is also increasingly providing a channel of asynchronous communication between faculty members and students. In the judgment of this Commission, research universities have a special responsibility to develop educational technology that offers students unique opportunities for learning. At the same time, technology cannot be a substitute for direct interactions between human minds.

Definitions of teaching load usually revolve around either how many hours a professor spends in the classroom or the total number of students being taught. However, if guided research becomes an important component of undergraduate education, the professor may well conduct research and class simultaneously but in a very different format. The old definitions of workload will have to be replaced. Time-worn assumptions and practices cannot be allowed to prevent needed change in undergraduate education.

Conventional economic assumptions have governed administrative as well as instructional costs. Universities usually behave as though administrative costs are capable of change in only one direction. It is in the nature of bureaucratic structures to grow, and unrestrained growth again and again absorbs resources that could support academic creativity. Growth in size does not necessarily mean increased usefulness. Universities must be willing to reexamine and re-evaluate every administrative function and pare away everything that cannot demonstrate its value. There must be a willingness to see how functions can be streamlined, combined, or eliminated in order to provide some of the resources that new educational initiatives demand.

We believe universities must recognize the urgency of addressing misdirections and inadequacies in the undergraduate experience, sharpen their own plans and timelines, and move quickly beyond the realm of interesting experiments and innovations to that of the institutionalization of genuine reform. The following recommendations include both general statements on issues of particular importance and specific suggestions for achieving the improvements recommended. Together they envision a major overhaul of baccalaureate education and consequently significant shifts in the balance of relationships of research, graduate, and undergraduate education.

I. Make Research-Based Learning the Standard

Undergraduate education in research universities requires renewed emphasis on a point strongly made by John Dewey almost a century ago: learning is based on discovery guided by mentoring rather than on the transmission of information. Inherent in inquiry-based learning is an element of reciprocity: faculty can learn from students as students are learning from faculty.

Important ideas rarely come fully-developed from the brain of a single individual; all scholars work from the grounding provided by predecessors, and few are not stimulated by the observations and criticisms of their peers. It is one of the functions of a university to provide the context in which ideas can be most productively developed. Bruce Alberts, President of the National Academy of Sciences and a member of the Boyer Commission, has referred to the "accidental collisions of ideas" necessary for the continued productivity of faculty, and has suggested that the presence of students provides a "lubrication" that breaks down intellectual barriers between faculty members. When students at every level—baccalaureate, masters', and doctoral—join with

SIGNS OF CHANGE

University Case Study
Studio Format for
Introductory Sciences

University
Rensselaer Polytechnic Institute

Rensselaer Polytechnic Institute has redesigned its large introductory science courses for more effective presentation; the traditional format, in which lecture, recitation, and laboratory sections were completely separate, were replaced by a 'studio' format, which integrates the three into one unified program taught in a single facility designed for the purpose. Students are divided into 12-15 "studio workshops," each taught by a single faculty member, with assistance from a graduate student and several undergraduates. Problem-solving, teamwork, and co-operative learning are emphasized.

SIGNS OF CHANGE

University Case Study
Problem-based Learning

University
University of Delaware

Problem-based learning was adopted in all basic science classes at the University of Delaware to promote active learning and connect concepts to applications. Students are not given all the information they need to solve the open-ended "real-world" problems, but are responsible for finding and using appropriate sources. They work in teams with access to an instructor; trained graduate or undergraduate students help lead some groups.

faculty in common inquiry, the opportunities for "accidental collisions of ideas" are optimized.

When asked why universities expect that teachers both conduct research and teach well, scholar-teachers are fond of replying that their teaching flows from what they have learned through research, and many also say that their research is affected by their teaching. Wayne C. Booth, Dean Emeritus at the University of Chicago and member of the Commission, expressed what many others have felt:

My books would have been quite different—and to me less valuable—if I had produced them in solitude or after talking only with professional colleagues. It was not just that thinking about how to teach students to read responsibly led me to ideas that I would otherwise have overlooked. Responding to students' rival readings actually changed my opinions about how to appreciate a given novel or work of criticism. For this and other reasons, teaching and publishing have always felt absolutely inseparable.

The non-researcher is too often limited to transmitting knowledge generated by others, but the scholar-teacher moves from a base of original inquiry. In a research university, students should be taught by those who discover, create, and apply, as well as transmit, insights about subjects in which the teacher is expert.

In reality, however, the undergraduate in our time may have little or no direct contact with established scholar-teachers. Instruction very often comes through the scholar's apprentice, the graduate student; the academic luminary featured in admissions bulletins appears rarely if at all in undergraduate classes, and then too often as the lecturer addressing hundreds of students at once. The context is intimidating for many, and they turn away in discouragement. Recognizing that discouragement, some research universities have responded by instituting smaller classes (though usually only for majors) conducted by senior faculty, or undergraduate seminars in which senior students are challenged to produce their own research.

The inquiry-based learning urged in this report requires a profound change in the way undergraduate teaching is structured. The traditional lecturing and note-taking, certified by periodic examinations, was created for a time when books were scarce and costly; lecturing to large audiences of students was an efficient means of creating several compendia of learning where only one existed before. The delivery system persisted into the present largely because it was familiar, easy, and required no imagination. But education by inquiry demands collaborative effort; traditional lecturing should not be the dominant mode of instruction in a research university.

The experience of most undergraduates at most research universities is that of receiving what is served out to them. In one course after another they listen, transcribe, absorb, and repeat, essentially as undergraduates have done for centuries. The ideal embodied in this report would turn the prevailing undergraduate culture of receivers into a culture of inquirers, a culture in which faculty, graduate students, and undergraduates share an adventure of discovery.

Involving Undergraduates in the Research Process

BECAUSE OF THE UNIQUE CHARACTER OF A RESEARCH UNIVERSITY, the process of discovery is essentially a public one; the results of research are, through both teaching and publication, offered publicly for critique, correction, and extension. Undergraduates need to become an active part of the audience for research. In a setting in which inquiry is prized, every course in an undergraduate curriculum should provide an opportunity for a student to succeed through discovery-based methods.

The basic idea of learning as inquiry is the same as the idea of research; even though advanced research occurs at advanced levels, undergraduates beginning in the freshman year can learn through research. In the sciences and social sciences, undergraduates can become junior members of the research teams that now engage professors and graduate students. In the humanities, undergraduates should have the opportunity to work in primary materials, perhaps linked to their professors' research projects. As undergraduates advance through a program, their learning experiences should become closer and closer to the activity of the graduate student. By the senior year, the able undergraduate should be ready for research of the same character and approximately the same complexity as the first-year graduate student; the research university needs to make that zone of transition from senior to graduate student easy to enter and easy to cross. For those who do not enter graduate school, the abilities to identify, analyze, and resolve problems will prove invaluable in professional life and in citizenship.

A Mentor for Every Student

GENERATIONS OF EXPERIENCED SCHOLARS HAVE KNOWN AND ACTED upon the knowledge that the intellectual development of their graduate students is most effectively guided in one-to-one relationships. Essentially the same techniques of tutorship have been practiced at the undergraduate level in areas like art and music, where individual performance is watched, corrected, assisted, and encouraged. In the process, an undergraduate student and instructor can develop a supportive relationship not unlike that found between doctoral candidate and advisor. This kind of mentoring needs to be emulated throughout universities.

In every discipline, field work and internships should be fostered to provide opportunities for original work. In professional schools, these experiences can occur on campus or externally through linkages with businesses, hospitals, associations, governmental agencies, etc. Professional schools operate primarily at the graduate level. Some, especially law schools, place an emphasis on breadth of background, and some medical schools follow the same kind of practice. But emphasis on breadth is seldom found in graduate schools of business and engineering. Graduate professional schools need to re-cast their admissions procedures to recognize the importance of the kinds of abilities that will be produced by integrated inquiry-based learning. When they do so, they will find their students more adaptive, more resourceful, and

SIGNS OF CHANGE

University Case Study
Undergraduate Research, URECA

University
State University of New York at Stony Brook

Any interested undergraduate at the State University of New York at Stony Brook may enter the URECA (Undergraduate Research and Creative Activities) Program, in which students work with faculty researchers and artists on selected projects of shared interest, on projects they devise themselves, or on an ongoing research project from one of the academic departments, professional schools, or research centers. Students may also find projects with Brookhaven National Laboratory, Cold Spring Harbor Laboratory, or North Shore University Hospital. Projects require faculty sponsorship and earn academic credit and expense allowances.

SIGNS OF CHANGE

University Case Study
Peer Instruction

University
Harvard

A Harvard professor, Eric Mazur, has developed a peer instruction technique, first used in introductory calculus-based physics courses, in which a third of class time is given to asking conceptual questions; student responses are recorded on classroom computers. Students are then asked to discuss their answers with classmates and, if necessary, revise their answers and levels of confidence in them. Finally, clarification of the concept is provided by the instructor, guided by original class responses and later reconsiderations.

SIGNS OF CHANGE

University Case Study
College Research Opportunities Program (CROP)

University
University of Chicago

Undergraduate students at the University of Chicago may participate in a wide variety of research projects in many disciplines, for which the students receive either academic credit or a salary. Positions are available with the university's on-campus research centers, including the Yerkes Observatory, the Ben May Institute for Cancer Research, the DNA Sequencing Facility, the Center for Medical Genetics, the Film Studies Center, the ARTFL Project (an on-line database of French texts from the 17th to the 20th centuries), the Council for Advanced Studies in Peace and International Cooperation, and the National Opinion Research Center, as well as with affiliated research centers such as the Fermi National Accelerator Lab.

better able to accommodate the challenges of specialized training and professional life, as well as the relation of such training to social responsibilities. Those professional schools that train undergraduate students need to accept the same goals that obtain in the arts and sciences. Undergraduate engineers and business majors, as much as their colleagues in literature and political science, will benefit from the educational model being proposed. Particularly in the first years of university life, students in the professional schools should share the common experience.

In the model the Commission proposes, scholar-teachers would treat the sites of their research as seminar rooms in which not only graduate students but undergraduates observe and participate in the process of both discovery and communication of knowledge. Those with knowledge and skills, regardless of their academic level, would practice those skills in the research enterprise and help to develop the proficiency of others. Even though few researchers ever escape the human temptation to compete for rewards, this model is collaborative, not competitive. It assumes that everybody—undergraduate, graduate student, and faculty member alike—is both a teacher and a researcher, that the educational-research process is one of discovery, not transmission, and that communication is an integral p[illegible] the shared enterprise.

Internships

INTERNSHIPS CAN OFFER AN INVALUABLE ADJUNCT TO RESEARCH-based learning by allowing the student concrete contexts in which to apply research principles. Whether a student has an internship in a physics lab, a news room, a hospital, or a business office, the experience can provide learning that cannot be replicated in the classroom. For undergraduates in the arts and sciences as well as in professional schools, these experiences provide useful, often interdisciplinary, learning and real-life problem solving. When students need to work to support their education, internships can make that economic requirement a valuable part of university experience.

Specific recommendations to implement this model include:

1. Beginning in the freshman year, students should be able to engage in research in as many courses as possible.
2. Beginning with the freshman year, students must learn how to convey the results of their work effectively both orally and in writing.
3. Undergraduates must explore diverse fields to complement and contrast with their major fields; the freshman and sophomore years need to open intellectual avenues that will stimulate original thought and independent effort, and reveal the relationships among sciences, social sciences, and humanities.
4. Inquiry-based courses should allow for joint projects and collaborative efforts.
5. Professional schools need to provide the same inquiry-based opportunities, particularly in the early years.

6. Provision of carefully constructed internships can turn inquiry-based learning into practical experience; internship opportunities need to be widely available.

II. Construct an Inquiry-based Freshman Year

The first year of a university experience needs to provide new stimulation for intellectual growth and a firm grounding in inquiry-based learning and communication of information and ideas.

The freshman year is crucially important. It marks a transition in the lives of young people both socially and academically. Many of them will spend a long period away from home for the first time and be required to make new friends and organize their lives without the close attention of families. Those who continue to live at home will have different schedules, different expectations, and different relationships. Freshmen who come directly from high school leave a structured academic program for an environment in which they bear far more personal responsibility for the nature of their learning.

The freshman year needs to perform two vital functions: it must be the bridge between high school and home on the one side and the more open and more independent world of the research university on the other, and it must excite the student by the wealth, diversity, scale, and scope of what lies ahead. If it does not perform both those functions successfully, the entire university experience is at risk.

Ironically, the first years of university studies, in many ways the most formative of all years, are usually the least satisfactory in terms of concept, curriculum, and pedagogy. Many universities find, to their great distress, that too many students spend time in the first year in remediation programs. Introductory courses often repeat subject matter that freshmen have studied for years rather than introducing new subjects that broaden their horizons and give them a sense of the adventure of learning. Too often the freshman curriculum is a bore and freshman instruction inadequate. Senior professors, when they teach undergraduates, tend to teach majors in advanced courses, although these students are usually the best equipped of all students for learning on their own in the subject of their chosen major. As a result, freshmen—the students who need the very best teaching—may actually receive the worst, and more of them fall away by the end of the freshman year than at any other time.

The first-year experience at most research universities was in the past governed by the perceived need to give every student a common base of knowledge. The "general education" requirements are now near extinction at many research universities; what has survived is often more influenced by internal university politics than educational philosophies. The freshman experience needs to be an intellectually integrated one, so that the student will not learn to think of the academic program as a set of disparate and unconnected requirements.

Every institution needs to rethink both what every future

SIGNS OF CHANGE

University Case Study
Block Scheduling

University
Duke University

First-semester Freshmen at Duke University may enroll in one of about 14 interdisciplinary, thematically-designed programs, in which they take two Focus seminars, a writing course, and a non-Focus elective. Enrollment in each is limited to 30; students in a program live together in a residence hall and meet weekly for dinner.

SIGNS OF CHANGE

University Case Study
LEAP

University
University of Utah

Entering freshmen at the University of Utah enroll in a year-long seminar led by one instructor and in quarterly Liberal Education Accelerated Program (LEAP) courses linked to the themes of the seminars. Some of these courses meet graduation requirements and some meet core or distribution requirements. LEAP students also enroll in a first-quarter study and computer skills course. Current and past LEAP students are members of the LEAP club, which provides organized social and academic activities such as study groups and guest speakers.

citizen, regardless of specialty or interests, needs to know in order to receive a degree and at what point that knowledge is best aquired. Radical change is thus essential to make the freshman year successful, a period of perhaps the fastest growth a student experiences during the college years.

Seminar Learning

THE FRESHMAN YEAR SHOULD BE RECONFIGURED FOR MAXIMUM benefit, and the sophomore year should evolve as a result of those changes. The focal point of the first year should be a small seminar taught by experienced faculty. The seminar should deal with topics that will stimulate and open intellectual horizons and allow opportunities for learning by inquiry in a collaborative environment. Working in small groups will give students not only direct intellectual contact with faculty and with one another but also give those new to their situations opportunities to find friends and to learn how to be students. Most of all, it should enable a professor to imbue new students with a sense of the excitement of discovery and the opportunities for intellectual growth inherent in the university experience.

Block Scheduling

A SUPPORTIVE ATMOSPHERE FOR ADJUSTMENT TO UNIVERSITY LIFE can be created by block scheduling cohorts of freshmen into two or three courses during their first semester or year. Groups can also be joined according to mutual curricular interests in living-learning centers or interest-focused residences.

Remediation Before Admission

THE CURRENT NATIONAL ATTENTION BEING GIVEN TO THE IDEA OF fixed graduation standards for public schools recognizes the deficiencies that too many students now bring to college. Entering students should be required to have satisfactory mathematics and oral and written language skills before taking any credit courses. Remediation should not be a function of a research university; for a research university to devote a large portion of its faculty time and its facilities to prepare students for university study represents a dissipation of increasingly scarce resources. Students should acquire the skills they need before entering credit-bearing courses. Intensive summer programs in mathematics and English may in many circumstances provide the necessary skills; students with serious deficits should attend other kinds of institutions prepared to handle their educational needs before enrolling in research universities. International students who need greater experience in spoken or written English should take intensive courses in English as a Second Language, in summers or first semesters, before entering the normal curriculum.

Recommendations:

1. A student embarking upon a degree program at a research university should be adequately prepared to meet the intellectual challenges of that program; if remediation is necessary, it should be completed before entering the program.
2. All first-year students should have a freshman seminar, limited

in size, taught by experienced faculty, and requiring extensive writing, as a normal part of their experience.

3. Every freshman experience needs to include opportunities for learning through collaborative efforts, such as joint projects and mutual critiques of oral and written work.
4. The freshman program should be carefully constructed as an integrated, interdisciplinary, inquiry-based experience by designs such as:
   a. Combining a group of students with a combination of faculty and graduate assistants for a semester or a year of study of a single complicated subject or problem.
   b. Block scheduling students into two or three first-semester courses and integrating those courses so that the professors plan together and offer assignments together.
   c. If possible, integrating those courses with the freshman seminar, so that there is a wholeness as well as a freshness to the first year.
   d. Taking advantage of time freed by advanced placement to explore areas not studied in high school in order to encourage students to range as freely as possible before selecting a major.

SIGNS OF CHANGE

University Case Study
Sophomore Dialogues and Seminars

University
Stanford University

At Stanford University, sophomores who choose to enroll in a Sophomore College program are housed together in student residences and enroll in small-group classes of approximately 10, led by one professor and two upper-class students. Participants earn 1 or 2 academic credits; examples of topics include "Constitutionalism," "Comparative American Urban Cultures," and "The Process of Discovery in Psychology." Workshops in use of university libraries, research opportunities, and academic decision-making are held.

III. Build on the Freshman Foundation

The freshman experience must be consolidated by extending its principles into the following years. Inquiry-based learning, collaborative experience, writing and speaking expectations need to characterize the whole of a research university education. Those students who enter the research university later than the freshman year need to be integrated smoothly into this special atmosphere.

After the freshman student is initiated into the life of the research university through a program that is innovative and exciting, the gains will be lost if the rest of the university experience does not match. Moving from a stimulating freshman seminar and an integrated program back into courses that seem unrelated, with requirements that do not evoke the newly-awakened spirit of research, would be dispiriting and disillusioning. So it is incumbent on the university to carry the reforms to every part of the curriculum.

This report does not address the issues of curricular change but rather the questions of how subject matter is presented and how intellectual growth is stimulated. The goal of making baccalaureate students participants in the research process requires faculties to reexamine their methods of delivering education, to ask how, in every course, students can become active rather than passive learners. That task, undertaken seriously, will produce many innovations suited to different disciplinary circumstances; the changes need to include greater expectations of writing and speaking, more active problem-solving, and more collaboration among baccalaureate students, graduate students, and faculty.

Long-term Mentorship

In a successful research experience, a relationship of trust and respect exists among the members of a team; shared goals and community

SIGNS OF CHANGE

University Case Study
Junior Independent Work and Senior Thesis

University
Princeton

All undergraduates at Princeton must conduct independent research or creative work during the junior year and submit a Junior Paper, which then becomes the basis for the required Senior Thesis.

often follow. Universities cannot expect that close personal relationships will or should exist between every student and the faculty members to whom that student has been exposed. But every student at a research university should be able to feel that some faculty member knows and appreciates that student's situation and progress and is ready to help that progress by setting standards to be met and by offering advice, encouragement, and criticism. To be effective, this kind of mentoring relationship needs to be created early and maintained when possible throughout a student's program. Such a relationship should go beyond the routine suggestions about choice of courses that many departments consider to be "advising"; it requires patience and commitment from the faculty member, but the relationships built can be mutually rewarding.

Integrating Transfer Students

RESEARCH UNIVERSITIES, PARTICULARLY THE STATE-SUPPORTED universities, very often accept into their upper-class majors large numbers of students who have begun their educations elsewhere, at community colleges, at liberal arts colleges, or at other universities. In is not unusual for students to attend more than one institution before settling. Their freshman experience is over, for better or for worse, but they need to be integrated into the atmosphere of the research university and given as much as possible of the kind of inquiry-based experience that they missed. Special seminars or similar courses for transfer students would make up a major part of the deficit.

Recommendations:

1. The inquiry-based learning, collaborative efforts, and expectations for writing and speaking that are part of the freshman experience need to be carried throughout the program.
2. Thoughtful and attentive advising and mentoring should integrate major fields with supporting courses so that programs become integrated wholes rather than collections of disparate courses.
3. Mentorships should begin as early as possible and should be maintained, whenever possible, throughout a student's academic career.
4. New transfer students need to be integrated into the research experience with special seminars or similar courses comparable to the freshman seminar.

IV. Remove Barriers to Interdisciplinary Education

Research universities must remove barriers to and create mechanisms for much more interdisciplinary undergraduate education.

In the earlier decades of the century, research was characteristically confined within traditional boundaries of disciplines that had themselves been defined only a few generations earlier. The anthropologist and the historian rarely ventured into each other's realms; nor did the chemist and the physicist. But in the years since World War II the continuing appearance of new departments and new programs that merge fields has proven repeatedly the permeability of the lines between disciplines. Individual researchers find that pushing the limits of their field takes them into new territories and that the work they are doing may have much more in common with that of colleagues across the campus than with members of their own departments.

The principal barrier to interdisciplinary research and study has been the pattern of university organization that creates vested interests in traditionally defined departments. Administratively, all educational activity needs to "belong" somewhere in order to be accounted for and supported; that which has no home cannot exist. Courses must be offered under some kind of sponsorship; students are asked to place themselves in one discipline or another. The limitations on this kind of structure are recognized in every university by defining new departments, approving new programs, and creating new centers in which to house courses, often experimental, that do not fit into the disciplines. But those centers repeatedly must call on the departments to teach the courses, knowing that the departments may balk at doing so since the interdisciplinary programs deplete staffing for their own departmental courses. Students who find that existing majors do not suit their interests often encounter discouraging barriers; advisors will likely first try to fit those interests into one of the existing patterns.

Breaking the Disciplinary Molds

AS RESEARCH IS INCREASINGLY INTERDISCIPLINARY, UNDERGRADUATE education should also be cast in interdisciplinary formats. Departmental confines and reward structures have discouraged young faculty interested in interdisciplinary teaching from engaging in it. But because all work will require mental flexibility, students need to view their studies through many lenses. Many students come to the university with some introduction to interdisciplinary learning from high school and from use of computers. Once in college, they should find it possible to create individual majors or minors without undue difficulty. Understanding the close relationship between research and classroom learning, universities must seriously focus on ways to create interdisciplinarity in undergraduate learning.

Recommendations:

1. Lower division courses should introduce students to interdisciplinary study.

SIGNS OF CHANGE

Name
World Courses

University
University of Maryland

"World Courses" at the University of Maryland College Park are team-taught lecture courses for core distribution credit; many integrate science with humanities or social science perspectives. Topics include "To Stem the Flow: the Nile, Technology, Politics, and the Environment," taught by faculty from Civil Engineering, Microbiology, and Government and Politics, and "The Creative Drive: Creativity in Music, Architecture, and Science," taught by Mathematics, Music, and Architecture faculty, focusing on the creative process as seen in jazz, modern buildings, and scientific chaos theory.

SIGNS OF CHANGE

University Case Study
Little Red Schoolhouse

University
University of Chicago

The "Little Red Schoolhouse" program at the University of Chicago is a one-quarter writing course taken each year by about 200 undergraduates. It is faculty taught, with assistance from doctoral-student writing interns. The interns are competitively selected and take a quarter-long training program themselves which teaches the "Schoolhouse" analysis of writing and techniques for adapting that analysis to the needs of individual students. In the Schoolhouse the students learn how to adapt their writing to evoke the responses they want and how to work effectively with other writers on revisions.

2. Academic majors must reflect students' needs rather than departmental interests or convenience.
3. Customizing interdisciplinary majors should be not only possible but readily achievable.

V. Link Communication Skills and Course Work

Undergraduate education must enable students to acquire strong communication skills, and thereby create graduates who are proficient in both written and oral communication.

The failure of research universities seems most serious in conferring degrees upon inarticulate students. Every university graduate should understand that no idea is fully formed until it can be communicated, and that the organization required for writing and speaking is part of the thought process that enables one to understand material fully. Dissemination of results is an essential and integral part of the research process, which means that training in research cannot be considered complete without training in effective communication. Skills of analysis, clear explanation of complicated materials, brevity, and lucidity should be the hallmarks of communication in every course.

At present, most writing in universities is addressed to professors who know more about the subject matter than the writers, but all students should be taught to write for audiences less informed on the topic than the writer. After college there will be little need to write "up" to a professor; it will be more important to write "down to an audience that needs information and/or opinions, even if that audience happens to be the employer or higher authority. The abilities to explain, to convey new information, and to condense materials for easy absorption will be essential for any profession.

Unfortunately, today's students too often think of composition as a boring English requirement rather than a life skill; moreover, hardly any are exposed to courses or class requirements in oral communication. Faculty too often think of composition as a task the English or composition department does badly, rather than understanding that an essential component of all faculty members' responsibility is making sure that their students have ample practice in both writing and speaking. In evaluating examinations and papers, faculty members are often willing to forgive grammatical and stylistic blunders, thinking such matters the responsibility of composition teachers, as long as they believe they can grasp the essence of the student's text; that behavior reinforces the assumption on the part of students that clear communication is not important.

Communication in Every Course

FROM THE FRESHMAN SEMINAR TO THE SENIOR CAPSTONE COURSE, communication skills should be integrated with the subject matter. Freshman composition must be cast in a new form intimately related to a student's other courses. Instructors throughout the curriculum need to build opportunities for written and oral presentations into their course outlines, so that experience and

confidence can grow continuously. Faculty members need to assign papers as part of normal course expectations and to create examinations that require demonstration of writing and analytical skills.

Communications must be similarly emphasized in the education of graduate students (see Section VIII below, Educate Graduate Students as Apprentice Teachers).

Recommendations:

1. All student grades should reflect both mastery of content and ability to convey content. Both expectations should be made clear to students.
2. The freshman composition course should relate to other classes taken simultaneously and be given serious intellectual content, or it should be abolished in favor of an integrated writing program in all courses. The course should emphasize explanation, analysis, and persuasion, and should develop the skills of brevity and clarity.
3. Writing courses need to emphasize writing "down" to an audience who needs information, to prepare students directly for professional work.
4. Courses throughout the curriculum should reinforce communication skills by routinely asking for written and oral exercises.
5. An emphasis on writing and speaking in graduate courses will prepare teaching assistants for research, teaching, and professional roles.

VI. Use Information Technology Creatively

Because research universities create technological innovations, their students should have the best opportunities to learn state-of-the-art practices—and learn to ask questions that stretch the uses of the technology.

Continuing technological development, particularly in the areas of information storage, retrieval, and communication, can be expected to alter the manner of teaching at every educational level and in every conceivable setting. We know that emerging technology is ceaselessly changing and will continue to change the ways in which the world functions and the ways in which people live. What we haven't been able to predict is exactly how. In the words of Milton Glaser, designer and Boyer Commission member, "technology is never neutral ." It is the role of universities to make technology positive.

No institutions are better suited to make a difference in our technological future than research universities. Much of what we think of as sophisticated technology was created in their halls, and there is every reason to believe that university scholars will lead the way to continuing improvements. Scientific benefits aside, research universities are particularly well suited to take advantage of technology for teaching undergraduates.

The Electronic Classroom

RESEARCH UNIVERSITIES, BECAUSE OF THEIR SIZE AND ACADEMIC

SIGNS OF CHANGE

University Case Study
Rhetoric Department Instructors

University
University of Iowa

Graduate instructors for required basic courses in reading, writing, speaking, and research are recruited not only from the English and Communication departments at the University of Iowa, but also from other humanities and social science departments such as African-American World Studies, Classics, History, and Philosophy. New teachers are provided with background material in the summer before they begin teaching, attend a 3-day intensive workshop before classes begin, and attend a weekly teaching colloquium, required for new faculty as well, during the fall semester. All graduate instructors are paired with faculty teaching advisors, with whom they share drafts of teaching materials and assignments and review students' progress. The department also assists the instructors in preparing a teaching portfolio.

mission, are far more likely than other institutions to possess the technological capabilities for twenty-first century teaching in any area. At many universities, computer networks, wired classrooms, and laser discs are used to bring recent research findings and methods directly into the classroom. Creative applications of technology abound. A few examples:

- At the University of California, Berkeley, a state-of-the-art center for video conferencing and intercampus instruction allows courses—some of them as esoteric as Armenian History or Medieval Catalan—to be offered in collaboration not only with other University of California campuses but with other universities both in the United States and abroad; they allow any student anywhere to interact with faculty and classmates in real time.
- A freshman non-major science course at the University of Texas uses multimedia software modules with 3-D visuals, animation, and sound in addition to text which has links to remedial and supplementary materials.
- Massachusetts Institute of Technology has developed a large-scale computer service agency that, among other functions, provides an on-line teaching assistants' program to answer student queries, distributes lectures through a cable-television network, and provides genetics-modeling software for biology courses.

It has become routine in universities for assignments to be sent and received and students' questions answered through electronic mail. If faculty give appropriate attention to teaching innovations, universities can become the technological pacesetters in teaching that they have always been in research; commercial developers await the products now. However, as innovations multiply, so do dangers: in many circumstances, casual over-use of technological aids already increases the real and psychological distance between living faculty members and living students. Technological devices cannot substitute for direct contact.

Enriching Teaching Through Technology

IT IS INCUMBENT UPON THE FACULTIES OF RESEARCH UNIVERSITIES to think carefully and systematically not only about how to make the most effective use of existing technologies but also how to create new ones that will enhance their own teaching and that of their colleagues. The best teachers and researchers should be thinking about how to design courses in which technology enriches teaching rather than substitutes for it. And equally important, faculties need to concern themselves with the need to give their students the tools with which they can explore deeply as well as widely, with which they can discriminate, analyze, and create rather than simply accumulate.

The more information a person can obtain, the greater the need for judgment about how to use it.

If anything is evident, it is that the more information a person can obtain, the greater the need for judgment about how to use it. Obtaining information from the Internet is easy; children in elementary school can do it. But who teaches students how to take advantage of this mass of information? Who teaches them

how to tell the difference between valuable information and clutter? How, in short, does a student become a more intelligent consumer in this supermarket of information? The answer, we believe, is by exposure to scholars—experienced, focused guides who have spent their lives gathering and sorting information to advance knowledge.

Technological devices cannot substitute for direct contact.

Recommendations:

1. Faculty should be alert to the need to help students discover how to frame meaningful questions thoughtfully rather than merely seeking answers because computers can provide them. The thought processes to identify problems should be emphasized from the first year, along with the readiness to use technology to fullest advantage.
2. Students should be challenged to evaluate the presentation of materials through technology even as they develop an increasing familiarity with technological possibilities.
3. Faculties should be challenged to continue to create new and innovative teaching processes and materials, and they should be rewarded for significant contributions to the technological enrichment of their courses.
4. Planning for academic units, such as block-scheduled courses for freshmen or required courses for individual majors, should include conscientious preparations for exercises that expand computer skills.
5. Active interchange between units on campus and through professional meetings should encourage and inspire faculty to create new computer capabilities for teaching and to share ideas about effective computer-based learning.

VII. Culminate With a Capstone Experience

The final semester(s) should focus on a major project and utilize to the fullest the research and communication skills learned in the previous semesters.

In order to ensure that the educational experience is drawn together, the student needs a course at the end of the curriculum that corresponds to the capstone of a building or the keystone of an arch. Too many students report a sense of anti-climax in their senior years—just add more to the total of courses, and it is finished! All the skills of research developed in earlier work should be marshaled in a project that demands the framing of a significant question or set of questions, the research or creative exploration to find answers, and the communication skills to convey the results to audiences both expert and uninitiated in the subject matter. When earlier course experience is inquiry-based, the student will be ready for and stimulated by the demands of this course. The nature of the experience will vary widely according to the major discipline of the student, but it should be of value equally to the budding social scientist, bench scientist, artist, humanist, engineer, or business major. The capstone experience needs to allow for collaborative effort whenever appropriate to the discipline, so

SIGNS OF CHANGE

University Case Study
Capstone Learning Experience

University
University of Wisconsin

A College of Agriculture requirement at the University of Wisconsin is a "problem-solving exercise, in which students under faculty supervision and mentorship, must solve a 'real-world' problem and address societal, economic, ethical, scientific, and professional factors in their solutions". The Capstone Learning Experience must involve more than one department or several areas within a single department. Final work is presented in written, oral, and visual reports.

SIGNS OF CHANGE

University Case Study
Capstone

University
University of Missouri-Columbia

The General Education Program at the University of Missouri, Columbia, mandatory for all students, includes a capstone experience, a senior seminar, thesis, project, performance, internship, or field work, on a topic appropriate to the student's major. The capstone experience is evaluated on both the "quality of the product of the student's investigation and the process of presentation."

that undergraduate students can be better prepared for participation in the team projects they will encounter in professional as well as private life.

The Culmination of Academic Effort

THE EXPERIENCE SHOULD ENABLE THE STUDENT TO BRING TO A symbolic conclusion the acquisition of knowledge and skills that has preceded this final effort. It should be conducted under the mentorship of a seasoned scholar-teacher who understands the joys and frustrations of a major project. It should allow the student to understand her or his potential for serious work and develop the aspiration to do it well. Ideally, the mentor for the capstone course may be the student's major advisor or a faculty member already familiar with his or her capabilities and experience.

Although each university will find unique embodiments of the capstone concept, ideally the experience will occur within a small community of learners comprising senior researchers, graduate students, and undergraduate peers. This course should be the bridge to graduate education for the holders of research university baccalaureate degrees who immediately enter graduate school. For graduates entering the work force, the course should provide experience in the analysis, team-building, and problem-solving that most professional situations demand.

We hope that many students will conduct these research or creative projects in interdisciplinary groups, choosing topics and using techniques that break through disciplinary barriers. The flexibility that should mark the graduate of a research university should be fully developed in this final, culminating experience.

Recommendations:

1. Senior seminars or other capstone courses appropriate to the discipline need to be part of every undergraduate program. Ideally the capstone course should bring together faculty member, graduate students, and senior undergraduates in shared or mutually reinforcing projects.
2. The capstone course should prepare undergraduates for the expectations and standards of graduate work and the professional workplace.
3. The course should be the culmination of the inquiry-based learning of earlier course work, broadening, deepening, and integrating the total experience of the major.
4. The major project may well develop from a previous research experience or internship.
5. Whenever possible, capstone courses need to allow for collaborative efforts among the baccalaureate students.

VIII. Educate Graduate Students as Apprentice Teachers

Research universities must redesign graduate education to prepare students for teaching undergraduate students as well as for other professional roles.

Although graduate education is not at the center of our concern, clearly the metamorphosis of undergraduate education at research universities can not occur without suitable adjustments in the way that graduate students are prepared for their professional roles. Over the last several decades, universities have prolonged doctoral study, but they have not necessarily improved it by doing so. A graduate degree is a professional degree, intended both to furnish credentials and to prepare students for their life's work. But important aspects of their life's work have been neglected or ignored in their doctoral programs, to their detriment and that of the undergraduates they are expected to teach.

More than half of all doctoral students will seek employment in colleges and universities, 54 per cent according to the National Research Council's 1995 Survey of Earned Doctorates. The percentage of Ph.D.'s who become faculty varies broadly between fields, ranging from 83 per cent of humanities majors to 22 per cent of engineering majors. Most future faculty, however, cannot realistically expect to find positions at the 3 per cent of the nation's colleges and universities that are research universities. Yet graduate education severely neglects the professional goal of the majority of students who will become college professors, that is to say, teaching.

Reshaping Professional Training

MANY STUDENTS GO DIRECTLY FROM THEIR BACHELOR'S DEGREES into graduate school. Suddenly they are expected to be experts in their fields; we forget that last year they were mere seniors. They have great needs to acclimate themselves to a very different kind of learning experience. Simultaneously, we burden them with the responsibilities of research or teaching assistantships. Although more affluent institutions may allow them a grace period before beginning their assistantships, too many plunge them directly into their duties. This situation can be most harmful when they begin teaching immediately, sometimes in fields that may well not be their specialty (for example, literature majors teaching composition or foreign language courses). Moreover, they are too often expected to know how to teach with little more than a few days or weeks of casual training and with little or no supervision throughout the year.

When these neophytes enter the classroom, they rarely come armed with serious training in pedagogy. Perhaps they will have a provided syllabus in a multi-sectional course; perhaps they will be placed in charge of sections of freshman mathematics or composition. Too often they will sense that spending time on teaching will hurt them by taking away from their concentration on their own study and research. The situation creates the greatest possibility for poor teaching at the time that the freshman needs the best teaching and mentoring. It also creates great stress at the time the new graduate student is most vulnerable, sometimes leading to early burnout and often to poor teaching.

There is a striking discrepancy now between the nature of graduate work and the nature of the professional careers for which

SIGNS OF CHANGE

University Case Study
Future Professoriate Project

University
Syracuse University

The Future Professoriate Project at Syracuse University, funded by Pew Charitable Trusts, helps develop the teaching abilities of graduate students. Faculty Teaching Mentors lead seminars on effective teaching and serve as advisors; Teaching Associateships provide advanced teaching assistants opportunities to teach classes on their own and to receive a Certificate in University Teaching, awarded by the Graduate School to Teaching Associates who compile a teaching portfolio, which includes observation results as well as examples of syllabi, assignments, and examinations.

THE FACTS

Graduate students who plan to go into teaching

Percentage of Ph.D. recipients in various fields, with definite employment commitments in the U.S., whose intended employment is in Academe (2 & 4-year colleges and universities and medical schools) or Other (not industry or government; "mainly composed of elementary and secondary schools and nonprofit organizations").

Field	Academe	Other	Total
All fields	**54%**	**17%**	**71%**
Humanities	83%	10%	93%
Social Sciences	54%	16%	70%
Life Sciences	53%	8.5%	61.5%
Education	50%	38%	88%
Physical Sciences	41.5%	3.5%	45%
Engineering	22%	2.5%	24.5%
Professional/ other	73%	11%	84%

From the National Research Council, 1995 Survey of Earned Doctorates

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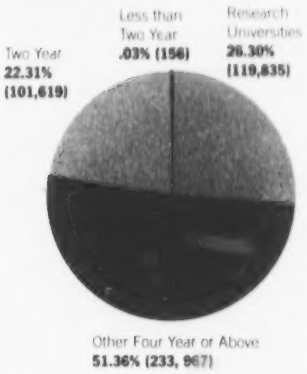
THE FACTS

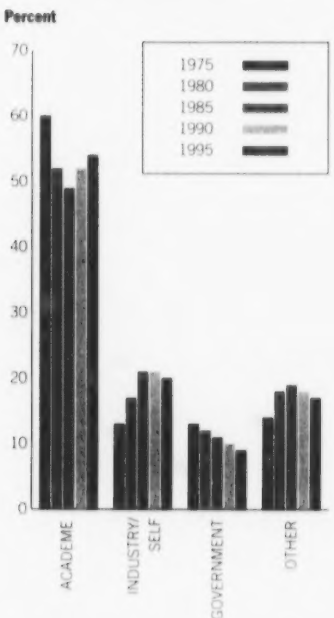
Where do faculty with Ph.D.'s work?



Source: 1994 IPEDS

THE FACTS

Employment sector of Ph.D. recipients with postgraduation commitments in the United States for selected years, 1975-1995 (U.S. citizens and permanent residents).



Note: Only Ph.D.s with definite commitments for employment are included. Foreign locations excluded. Percentages are based on the number of Ph. D.s whose employment sector is known. Government includes federal, state and local government agencies in the United State.

Source: National Research Council, Survey of Earned Doctorates

graduate students are being prepared. In particular, people educated to the doctoral level are expected by their employers and by society to be highly proficient in their fields, to be able to evaluate the work of others, to be producers of knowledge that will enrich or improve life, and to be effective communicators to whatever audiences are appropriate. Corporate leaders who recruit new Ph.D.'s seek employees who are accomplished at teamwork, at critical thinking, problem-solving, and oral and written communication. Yet graduate education too often ignores all those expectations. Graduate students are given intensive work in narrowly defined subjects and meticulous training in the technical skills required for research projects; it is the unstated assumption that the other expectations will be met without organized effort—met, presumably, by the general education that preceded graduate training. For too many people, that assumption is unwarranted.

Restoring Communication

NOWHERE ARE THE FAILURES OF GRADUATE EDUCATION MORE serious than in the skills of communication. Corporate leaders complain that new Ph.D.'s too often fail as communicators and cannot advance their own careers or contribute to the success of their companies. Again and again, effective communication proves to be at least as important as specific knowledge content or technological training.

The importance of communications skills for academic careers is, of course, self-evident, for professors must teach, lecture to colleagues, and publish their research. Yet the skills of writing and speaking are by and large ignored in graduate education, certainly not taught as essential skills required for graduation. Obviously, the lack of emphasis on these skills, even when graduate students become teaching assistants, has a profound effect on undergraduate education.

No student lacking in basic English skills should be expected or required to enter a classroom to teach. The issues here are far bigger than those of accent and grammar; the teacher in any course must also be a teacher of writing and speaking skills. Any graduate student, therefore, who does not possess these skills must acquire them in order both to graduate and to teach.

Solving the Teaching Crisis

GIVEN THE FACT THAT SO MANY DOCTORAL STUDENTS ARE preparing for academic careers, the reconstitution of doctoral programs will have a profound effect on undergraduate education. If undergraduate programs truly produce good communications skills, then the alumni of those programs will begin their graduate study well prepared, thus reducing the crisis in writing and speaking abilities that exists now in courses taught by some teaching assistants.

Ideally, teaching assistants will also use their classroom opportunities to foster the ability to frame questions, to seek answers independently, and to think in interdisciplinary ways. As those abilities are essential to doctoral study, so they should be initiated

and encouraged in undergraduates from their earliest courses, i.e. those often taught by teaching assistants.

Some universities are giving greater emphasis to teaching techniques as part of graduate student education, but few have explored mentoring relationships or the synergy of these interactions (i.e., how do undergraduates teach graduates, and how do graduates stimulate the intellectual growth of faculty members?).

Teaching is a difficult enough task in any setting, and in a research university the difficulties are magnified. The faculties of research universities must demonstrate to their graduate students how to lead undergraduates on their journeys of inquiry and discovery, and graduate students must master those teaching skills if they are to succeed as faculty members. Overdue as those ideas may be, undergraduates can expect to benefit when they are fully put in practice.

Recommendations:

1. All graduate students should have time to adapt to graduate school before entering classrooms as teachers.
2. Graduate apprentice teachers should be assisted by one or more of the following means: seminars in teaching, thoughtful supervision from the professor assigned to the course, mentoring by experienced teachers, and regular discussions of classroom problems with other new teachers.
3. Graduate students should be made aware of their classroom roles in promoting learning by inquiry. They should not be limited to knowing the old modes of transmission of knowledge without understanding the role of student and faculty as joint investigators.
4. Graduate courses need particular emphasis on writing and speaking to aid teaching assistants in their preparation for teaching as well as research functions.
5. Graduate students should be encouraged to use technology in creative ways, as they will need to do in their own careers.
6. Compensation for all teaching assistants should reflect more adequately the time and effort expected.
7. Graduate students should be encouraged through special rewards for outstanding teaching. Financial awards should be established for outstanding teaching assistants. The permanent faculty should make it clear through these awards and through all they do that good teaching is a primary goal of graduate education.

IX. Change Faculty Reward Systems

Research universities must commit themselves to the highest standards in teaching as well as research and create faculty reward structures that validate that commitment.

In 1895, the first president of the University of Chicago, William Rainey Harper, asked each new faculty member to agree in writing that advancements in rank and salary would be governed chiefly by research productivity. His stipulation, novel in its

SIGNS OF CHANGE

University Case Study
Undergraduate Teaching Initiatives

University
University of Virginia

At the University of Virginia, a Teaching Resource Center was created in 1990, funded primarily by reallocation. It offers evaluation, including videotaped critiques, and teaching improvement workshops, especially for teaching assistants and junior faculty. It also offers graduate courses on effective teaching strategies for special subjects. Outstanding Teaching Awards, five awards of $2,000 each, have been given annually since 1990-91.

SIGNS OF CHANGE

University Case Study
Rhetoric Program

University
University of Iowa

The Rhetoric Department recruits graduate instructors for its basic required courses in reading, writing, speaking and research from about fourteen departments, from African-American World Studies to Political Science to Religion. Before they teach, the instructors receive materials, including a 75-page set of Rhetoric Guidelines, and have a three-day intensive workshop on teaching. A weekly two-hour teaching colloquium is required in the fall. Faculty teaching advisors look over drafts of teaching materials and assignments and discuss student portfolios and exams. These advisors are rotated annually so that graduate instructors experience different points of view. Teaching portfolios are developed before graduate students look for jobs.

SIGNS OF CHANGE

University Case Study
Eberly Center

University
Carnegie Mellon University

The Eberly Center at Carnegie Mellon University, founded in 1982, conducts programs to provide faculty and teaching assistants with an understanding of the learning process and varied teaching strategies, and offers opportunities for feedback on course design and implementation. Programs emphasize theory, modeling, practice, and feedback and draw on cognitive science research; for example, cross-disciplinary studies of expert-novice differences help faculty understand the difficulties that students new to a subject might have in setting up problems, transferring knowledge to new settings, and interpreting complex patterns.

time, would raise few eyebrows in most research universities a century later. They might claim otherwise, but research universities consider "success" and "research productivity" to be virtually synonymous terms.

The typical department in a research university will assert that it does place a high value on effective teaching at the baccalaureate level. It will be able to cite faculty members among its ranks who take conspicuous pride in their reputations as successful teachers; it may be able to point to student evaluations that give consistently high ratings to many of its members. At the same time, however, discussions concerning tenure and promotion are likely to focus almost entirely on research or creative productivity. The department head when making salary recommendations may look almost exclusively at the grants or publication record. The junior faculty member who seems to give disproportionate time and attention to freshman/sophomore courses may well be counseled toward more "productive" redirection; if interest is shown in experimental or interdisciplinary courses at the baccalaureate level, movement toward tenure or promotion may be stalled. The "needs of the department" will be perceived as not being met.

What happens within the department is echoed and reinforced among the established disciplines on a national scale. The professional associations do not as a rule see their responsibilities as embracing the teaching function, even though it is inspired teaching that attracts young minds and pulls new recruits into the disciplines. The national conferences of the disciplines rarely offer sessions dealing with teaching effectiveness, and when they do so, those sessions are likely to be poorly attended.

Synergy of Teaching and Research

THE UNIVERSITY'S ESSENTIAL AND IRREPLACEABLE FUNCTION HAS always been the exploration of knowledge. This report insists that the exploration must go on through what has been considered the "teaching" function as well as the traditional "research" function. The reward structures in the modern research university need to reflect the synergy of teaching and research—and the essential reality of university life: that baccalaureate students are the university's economic life blood and are increasingly self-aware.

The kind of collaborative exploration that is urged here cannot be carried on in lecture sessions with hundreds of students. Budgetary constraints and the nature of survey courses may mean that some such courses continue; still, the teaching schedule of each faculty member needs to provide for small-group situations for baccalaureate students and a context that places them in joint exploration. Faculty course loads must also allow for research mentoring as part of normal operations rather than as poorly-compensated overloads.

Universities rightly assume that whoever appears in front of their classrooms can command the material that should be conveyed. Rare individuals can also captivate and stimulate student audiences, large and small, with their dynamic classroom

presentations. Since it is likely that most universities will need to retain some large classes, those individuals capable of striking success in the classroom should be suitably rewarded. Recognition as distinguished teacher-scholars should include added remuneration.

Evaluating Teaching

IN CALCULATING ACADEMIC REWARDS, IT HAS BEEN PAINFULLY difficult to evaluate the quality of research as separated from its mass. Nevertheless, departments and deans find that for passing judgment on peers, research productivity is a much more manageable criterion than teaching effectiveness. Faculty gossip, student evaluations, and alumni testimonials have all been notoriously weak reeds, and reliable self-evaluation is all but impossible. The publication of *Scholarship Assessed*, begun by Dr. Boyer before his death and published by the Carnegie Foundation for the Advancement of Teaching, pursues the issues of evaluating research. Recently the National Research Council has initiated a major study on how to evaluate science and mathematics teaching. But at this point promotion and tenure committees still find teaching effectiveness difficult to measure. Publication is at least a perceptible tool; the relative ease of its use has reinforced the reliance on it for tenure and promotion decisions. Evaluating good teaching will always be difficult, but effective integration of research and teaching should be observable, as should the development of interdisciplinary approaches to learning. Departments and deans must be pressed to give significant rewards for evidence of integrated teaching and research and for the imagination and effort required by interdisciplinary courses and programs. When publication is evaluated, attention should be paid to the pedagogical quality of the work as well as to its contribution to scholarship.

It has been emphasized here that a university is a community of learners. Some of them are more experienced than others; some are far along the way toward academic maturity, and some are not. Still, all are committed to the exploration of defined areas of knowledge, and in the university as envisioned here, they work together. Faculty members, graduate students, baccalaureate students all bring their particular combinations of energy, imagination, experience, and accumulated knowledge to bear. The divisions that have been created between them are artificial and counter-productive and must be bridged for effective collaborations to occur. All members of an academic team can share in the efforts and the rewards.

Recommendations:

1. Departmental leaders should be faculty members with a demonstrated commitment to undergraduate teaching and learning as well as to traditionally defined research.
2. The correlation between good undergraduate teaching and good research must be recognized in promotion and tenure decisions.
3. A "culture of teaching" within departments should be cultivated to heighten the prestige of teaching and emphasize the linkages between teaching and research.

SIGNS OF CHANGE

University Case Study
Redefining Scholarship

University
Syracuse University

Syracuse University has undertaken a program to redress a perceived overemphasis on research at the expense of teaching. The program has included conferences to enlist administrative support for change and a redefinition of "research and scholarship" by each division to include "the scholarship of teaching." A chancellor's fund was established to support the necessary changes, and a faculty grant program was created to reward teaching excellence and to provide funds for innovations.

SIGNS OF CHANGE

University Case Study
Integrated Undergraduate-Faculty Development

University
University of South Carolina

The Integrated Undergraduate-Faculty Development Program at the University of South Carolina includes funding for sending professors to conferences on pedagogy and for supporting curricular innovation; a mentoring program funded by a Lilly Foundation grant assists untenured junior faculty members by pairing them with experienced senior faculty.

4. Prestigious professional research meetings such as national disciplinary conferences and the Gordon Conferences should contain one or more sessions that focus on new ideas and course models for undergraduate education.
5. Sponsors of external research grants can and should promote undergraduate participation, as the National Science Foundation has begun to do, thus facilitating the research experiences of undergraduates.
6. Rewards for teaching excellence, for participation in interdisciplinary programs, and for outstanding mentorship need to be in the form of permanent salary increases rather than one-time awards.
7. Teachers capable of inspiring performance in large classes should be recognized and rewarded appropriately.
8. Committee work at all levels of university life should be greatly reduced to allow more time and effort for productive student-related efforts.

X. Cultivate a Sense of Community

Research universities should foster a community of learners. Large universities must find ways to create a sense of place and to help students develop small communities within the larger whole.

Diversities of many kinds characterize research universities, which must balance the needs of residential students and commuters, recent high school graduates and returning professionals, native-born and international students. There is more of everything—more students, more professors, more courses, more books in the library, more computers, more laboratories, more student activities. Clearly the complexity of these intellectual cities can give students the opportunity to create their own customized communities within, but that complexity can also be baffling and overwhelming to students, making them feel lonely, remote, and too anxious for optimal learning.

A sense of community is an essential element in providing students a strong undergraduate education in a research university. Whereas graduate students may readily gravitate to disciplinary colleagues around common research interests, beginning undergraduates rarely arrive with common intellectual connections.

The importance of a sense of personal identity within both large and small communities at the research university entered every discussion of the Boyer Commission. The campus must be a purposeful place of learning in which every student feels special connections. But that personal awareness of connections cannot occur unless there is a responsiveness to place and community. Therefore shared rituals play a powerful role in creating the larger university community in which the smaller, personalized communities of learners can coalesce. Whether the traditions are student convocations, pep rallies or football games, campus-wide celebrations, candlelight ceremonies, or graduation exercises, university-wide traditions feed the need for a connection with

place, a unique campus character. These rituals create the aura for a community of learners comprising all members of the university linked by intellectual interests, community values, and interpersonal relations.

Diversity as an Asset

RACIAL AND ETHNIC DIVERSITY IS A CRITICAL ELEMENT IN BUILDING community values, although it is still usually perceived as a problem instead. The presence of international students and nationals of many kinds of backgrounds gives research universities a richness of texture unavailable in most American communities; the challenge facing universities is to make that texture a positive element in the lives of all students. Many extracurricular activities and clubs build on shared interests, sometimes ethnic, religious, or cultural, but sometimes totally race- and ethnicity-blind. Members of an orchestra, for example, care about and rely upon each other's musicianship, not on similarities of background; members of a basketball or mathematics team, actors in a play, or journalists on the student newspaper want the best performers as their colleagues, regardless of ethnicity. Through experiences outside the classroom, students profit from different approaches to the same issues.

Racial and ethnic diversity is a critical element in building community values although it is still usually perceived as a problem instead.

The same is true within the classroom. Students enhance the texture of their learning by listening and interacting with faculty and students from different ethnic and cultural backgrounds. Faculty and graduate students become partners and guides for undergraduate study groups and project teams through collaborative learning. When students work in collaborative projects, they can benefit from the range of experiences and perspectives that different backgrounds provide. Diversity of backgrounds and approaches enriches the process of discovery, the ways of thinking about solving problems, the multiple modes of communicating ideas. Therefore a comfort level with difference, as well as flexibility to learn in various ways, must emanate from the institution.

Linking Commuters and Residents

COMMUTERS AND RESIDENTIAL STUDENTS ALIKE NEED TO KNOW that they are needed and valued members of the community. Most research universities include large numbers of both commuter students and residents, yet club and community activities tend to be geared for the convenience of the residents and inconvenience of the commuters. Part of the experience of diversity involves the commingling of these two groups, whose experience outside the classroom may be very different. Commuters, who often stay on campus just long enough for their classes, should be drawn into more interaction with residential students, graduate students, and faculty, through collaborative learning situations, co-curricular activities, and shared rituals and celebrations.

Recommendations:

1. Research universities need to cultivate a sense of place through appropriate shared rituals that are attractive to the widest

possible constituencies within the student population.

2. The enriching experience of association with people of diverse backgrounds, ethnicities, cultures, and beliefs must be a normal part of university life.
3. Residence halls should nurture community spirit.
4. Commuting students must be integrated into university life by making their participation easy and attractive.
5. Collaborative study groups and project teams should be used as a means of creating customized communities for residential and commuting students.
6. Common interests, such as that in maintaining the beauty of the campus setting or supporting charitable or service projects, should be cultivated by creating teams that build community as they work toward a shared goal.
7. Major issues forums, multicultural arts programming, and other extracurricular sharing of ideas, opinions, and arts bring students together, particularly when groups or clubs sponsor or help sponsor the events.
8. Campus programming, such as lectures and performing arts programs, taken as a whole, need to touch the interests of as many audiences as possible.

Common interests should be cultivated by creating teams that work toward shared goals.

CONCLUSION

Research universities are so complex, so multifaceted, and often so fragmented that, short of major crisis, they can rarely focus their attention on a single agenda. We believe that the state of undergraduate education at research universities is such a crisis, an issue of such magnitude and volatility that universities must galvanize themselves to respond. Insofar as they have seen as their primary responsibility the creation and refinement of knowledge, America's research universities have been superbly successful; in ways innumerable and immeasurable they have been the wellsprings of national stature and achievement. But in the education of undergraduates the record has been one of inadequacy, even failure. In a context of increasing stress—declining governmental support, increased costs, mounting outside criticism, and growing consumerism from students and their families—universities too often continue to behave with complacency, indifference, or forgetfulness toward that constituency whose support is vital to the academic enterprise. Baccalaureate students are the second-class citizens who are allowed to pay taxes but are barred from voting, the guests at the banquet who pay their share of the tab but are given leftovers.

Research universities are so complex, so multifaceted, and often so fragmented that, short of major crisis, they can rarely focus their attention on a single agenda.

Captivated by the excitement and the rewards of the research mission, research universities have not seriously attempted to think through what that mission might mean for undergraduates. They have accepted without meaningful debate a model of undergraduate education that is deemed successful at the liberal arts colleges, but they have found it awkward to emulate. The liberal arts model required a certain intimacy of scale to operate at its best, and the research universities often find themselves swamped by numbers. The model demands a commitment to the intellectual growth of individual students, both in the classroom and out, a commitment that is hard to accommodate to the research productivity that brings research universities recognition, professional advancement, and financial security. Almost without realizing it, research universities find themselves in the last half of the century operating large, often hugely extended undergraduate programs as though they are sideshows to the main event. The numbers are there but the attention is elsewhere. It is the purpose of this report to try to bring the undergraduates into the big tent, to explore what kind of education a research university might offer that would fully fit its character and take advantage of its resources.

Commitment to Dramatic Change

FOR DECADES WE HAVE EMPLOYED THE RHETORIC OF CHANGE; FOR decades experiments have been undertaken. Now those experiments are becoming more varied, sometimes more successful, and often more serious. Some funding agencies have directed money and attention to undergraduate issues. Still, considering the nation as a whole, efforts have been timid, sporadic, limited, and unavailing. We believe that universities must commit to significant transformation now. Research universities must be willing to approach the issue of undergraduate education free from the blinders of past practice, to ask basic questions and be prepared for answers that require radical reformation of methods of operation. Given the scale of the institutions and the multitude of interests touched, change will be anything but easy. The commitment to dramatic change, not half measures, must be made now, and action must respond to the urgency of the issue.

We believe that the basic direction of change is clear: undergraduates need to benefit from the unique opportunities and resources available in research universities; clumsy adaptations of the practices of liberal arts colleges will no longer serve. The research universities need to be able to give to their students a dimension of experience and capability they cannot get in any other setting, a research experience that is genuine and meaningful. They should turn out graduates who are well on the way to being mature scholars, articulate and adept in the techniques and methods of their chosen fields, ready for the challenges of professional life or advanced graduate study. Research universities have unique capabilities and resources; it is incumbent upon them to equip their graduates to undertake uniquely productive roles.

The recommendations in this report may not attract every institution, but we hope that faculties will be motivated to debate the issues raised here and to accelerate their pace of action. In the hope of speeding that process, we have established a home page [http://www.sunysb.edu/boyerreport] where discussions may continue.

Research universities cannot continue to operate as though the world around them is that of 1930 or 1950 or 1980. As everyone knows, it is changing with dizzying rapidity. These universities must respond to the change; indeed, they ought to lead it. Their students, properly educated for the new millenium, will be required as leaders while that world continues to transform itself.

In the Preface to his 1990 study, *Scholarship Reconsidered*, Ernest Boyer wrote, "the most important obligation now confronting the nation's colleges and universities is to break out of the tired old teaching versus research debate and define, in more creative ways, what it means to be a scholar." This report hopes to refine the context of that remark and to affirm that the most important obligation now confronting research universities is to define in more creative ways what it means to be a research university committed to teaching undergraduates. The nation demands and deserves no less.

APPENDIX A

American Research Universities

FOLLOWING ARE THE INSTITUTIONS CLASSIFIED BY THE CARNEGIE FOUNDATION FOR THE ADVANCEMENT of Teaching as research universities. The universities offer a full range of baccalaureate programs (with two exceptions, as noted), are committed to graduate education through the doctorate (50 or more degrees each year), and give high priority to research, including a minimum of $15.5 million (Research II) or $40 million (Research I) in annual federal support.

Arizona State University
Auburn University
Boston University
Brandeis University
Brigham Young University
Brown University
California Institute of Technology
Carnegie Mellon University
Case Western Reserve University
Clemson University
Colorado State University
Columbia University
Cornell University
Duke University
Emory University
Florida State University
Georgetown University
George Washington University
Georgia Institute of Technology
Harvard University
Howard University
Indiana University (Bloomington)
Iowa State University
Johns Hopkins University
Kansas State University
Kent State University
Lehigh University
Louisiana State University
Massachusetts Institute of Technology
Michigan State University
Mississippi State University
New Mexico State University
New York University
North Carolina State University
Northeastern University
Northwestern University
Ohio State University
Ohio University
Oklahoma State University
Oregon State University
Pennsylvania State University
Princeton University
Purdue University
Rensselaer Polytechnic Institute
Rice University
Rockefeller University*
Rutgers University (New Brunswick)
St. Louis University
Southern Illinois University (Carbondale)
Stanford University

State University of New York (Albany)
State University of New York (Buffalo)
State University of New York (Stony Brook)
Syracuse University
Temple University
Texas A&M University
Texas Tech University
Tufts University
Tulane University
University of Alabama (Birmingham)
University of Arizona
University of Arkansas
University of California (Berkeley)
University of California (Davis)
University of California (Irvine)
University of California (Los Angeles)
University of California (Riverside)
University of California (San Diego)
University of California (San Francisco)*
University of California (Santa Barbara)
University of California (Santa Cruz)
University of Chicago
University of Cincinnati
University of Colorado (Boulder)
University of Connecticut
University of Delaware
University of Florida
University of Georgia
University of Hawaii (Manoa)
University of Houston
University of Idaho
University of Illinois (Chicago)
University of Illinois (Urbana-Champaign)
University of Iowa
University of Kansas
University of Kentucky
University of Maryland (College Park)
University of Massachusetts (Amherst)
University of Miami
University of Michigan (Ann Arbor)
University of Minnesota (Twin Cities)
University of Mississippi
University of Missouri (Columbia)
University of Nebraska (Lincoln)
University of New Mexico
University of North Carolina (Chapel Hill)
University of Notre Dame
University of Oklahoma (Norman)
University of Oregon
University of Pennsylvania
University of Pittsburgh
University of Rhode Island
University of Rochester
University of South Carolina (Columbia)
University of Southern California
University of South Florida
University of Tennessee (Knoxville)
University of Texas (Austin)
University of Utah
University of Vermont
University of Virginia
University of Washington
University of Wisconsin (Madison)
University of Wisconsin (Milwaukee)
University of Wyoming
Utah State University
Vanderbilt University
Virginia Commonwealth University
Virginia Polytechnic Institute
Washington University
Washington State University
Wayne State University
West Virginia University
Yale University
Yeshiva University

* No undergraduate degrees awarded

APPENDIX B

Membership of the Boyer Commission

Bruce Alberts

A respected biochemist and molecular biologist, National Academy of Sciences President Bruce Alberts has dedicated much time to teacher improvement projects such as City Science in San Francisco. One of the principal authors of *The Molecular Biology of the Cell*, a textbook used widely in American colleges and universities, Dr. Alberts has served on a number of prestigious advisory and educational boards including Chair of the National Research Council's Commission on Life Sciences. Until his election as President of the Academy in 1993, he was President-elect of the American Society of Biochemistry and Molecular Biology. A native of Chicago, Dr. Alberts is a graduate of Harvard, from which he received an undergraduate degree in biochemical sciences and his doctorate. In 1976, after 10 years on the Princeton faculty, he was appointed professor and vice-chair of the Biochemistry and Biophysics Department of the University of California, San Francisco. In 1980, he was awarded an American Cancer Society Lifetime Research Professorship at UCSF and in 1985 named department chair. Known for his extensive study of the protein complexes that allow chromosomes to replicate as living cells divide, he also co-authored *Essential Cell Biology* (1998), a text designed to explain the subject to a more general audience.

Wayne C. Booth

Veteran educator and author Wayne C. Booth spent 30 years teaching at the University of Chicago where he held the George M. Pullman Chair and is currently a Distinguished Service Professor Emeritus in the English Department. His works include *The Rhetoric of Fiction, Now Don't Try to Reason With Me: Essays and Ironies for a Credulous Age, The Company We Keep: An Ethics of Fiction, The Art of Growing Older,* and *The Craft of Research.* Born and raised in Utah, Dr. Booth holds a bachelor's degree from Brigham Young University and a master's degree and doctorate from the University of Chicago. He is a past President of the Modern Language Association of America and has served on numerous executive committees and commissions ranging from the National Council of Teachers of English to the Commission on Literature of the National Council on Religion in Higher Education. He is a past recipient of a Guggenheim Foundation fellowship and has also been recognized by the American Academy of Arts and Sciences, the National Endowment for the Humanities and Phi Beta Kappa.

Milton Glaser

One of the world's best-known designers, Milton Glaser has been an active member of both the design and education communities since the start of his career. His work encompasses a wide range of design disciplines including print graphics, environmental and interior design, and posters for the arts as well as commercial projects and services. His graphic and architectural commissions include the I❤NY logo for New York State, an international AIDS symbol for the World Health Organization, the logo for Tony Kushner's Pulitzer Prize-winning play, "Angels in America," and redesigns of an international collection of publications including *L'Espresso* (Rome), *Alma* (Paris), *The Washington Post, The Village Voice* and *The Nation.* He is co-founder of *New York Magazine* for which he served as art director until 1977. Born in New York City, Glaser was educated at the Cooper Union Art School, New York, and later, via a Fulbright Scholarship, attended the Academy of Fine Arts, Bologna, Italy. The recipient of numerous honorary degrees and awards, he teaches and is on the board of the School of Visual Arts, New York City, and is a member of the board of Cooper Union.

He is a past President of the International Design Conference and served as Vice-President and national convention co-chair of the American Institute of Graphic Arts. His work is represented in the permanent collections of the Museum of Modern Art, New York; the Israel Museum, Jerusalem; The Chase Manhattan Bank, New York; and the National Archive, Smithsonian Institution, Washington, D.C.

Charles E. Glassick

Senior Associate of The Carnegie Foundation for the Advancement of Teaching, Charles E. Glassick has long played a pivotal role in the shape and substance of higher education. As President of Gettysburg College from 1977 to 1989, he was named one of the 100 "most effective college presidents" in the country. Dr. Glassick, who did his undergraduate work at Franklin and Marshall College, Pennsylvania, and earned master's and doctoral degrees in chemistry from Princeton, served as Interim President of The Carnegie Foundation for the Advancement of Teaching. A past Vice-Chairman of The Carnegie Foundation board, he also was a senior fellow, assisting the late Ernest L. Boyer in preparing major Carnegie reports including *Campus Life: In Search of Community* and *Scholarship Reconsidered: Priorities of the Professoriate.* He is co-author of *Scholarship Assessed.* Dr. Glassick was President of the Robert W. Woodruff Arts Center, Atlanta, Georgia, from 1991 to 1995 and is the recipient of many honorary degrees and awards.

Stanley O. Ikenberry

Chairman of the Board of Trustees of the Carnegie Foundation for the Advancement of Teaching and President of the American Council on Education, Stanley O. Ikenberry has been involved in higher education at the national level throughout most of his career. Former President of the University of Illinois, he also led the boards of the National Association of State Universities and Land Grant Colleges and the Association of American Universities. Prior to assuming the Presidency of the University of Illinois, Dr. Ikenberry was Senior Vice President of Pennsylvania State University and was a professor in Pennsylvania State Center for the Study of Higher Education. Born in Colorado, he received his undergraduate degree from Shepard College, West Virginia, and his master's and doctoral degrees from Michigan State University. He holds eight honorary degrees and has served on numerous commissions, boards and councils including the Presidents Work Group on Accreditation of Higher Education in America, which he chaired. He is on the board of Pfizer Inc., New York; UtiliCorp United, Kansas City; and the National Museum of Natural History, Washington, D.C. Dr. Ikenberry is also the author of numerous studies, articles and reports including *A Higher Education Map for the 1990's.*

Kathleen Hall Jamieson

Communicator and educator Kathleen Hall Jamieson is familiar to television audiences as the result of her frequent appearances on The NewsHour with Jim Lehrer and as a commentator for CBS News during national elections. Dean of the Annenberg School for Communication at the University of Pennsylvania, she is also a prolific author whose books and articles are widely respected by media watchers and the general public. Her most recent book, written with Joseph Cappella, is *Spiral of Cynicism: Press and Public Good.* She is a frequent contributor to *The New York Times, The Washington Post, The Philadelphia Inquirer* and *The Chronicle of Higher Education.* A graduate of Marquette University, from which she received a bachelor's degree, she holds a master's degree and Ph.D. from the University of Wisconsin. She was appointed Dean of the Annenberg School for Communication in 1989 after a teaching career that took her to the University of Maryland and the University of Texas, where she served as a Professor of Communications and Chair of the Speech Communication Department. The recipient of more than two dozen grants and fellowships, she has studied the way the public learns about public policy through a Robert Wood Johnson grant; has explored media, participation, finance and democracy with the aid of a MacArthur Foundation grant; and looked at East-West Rhetoric as the result of a National Endowment for the Humanities grant. She was also the recipient of Ford, Fulbright and Knapp fellowships, an Eli Lilly Foundation grant and a grant from the Andrew Mellon Foundation.

Shirley Strum Kenny

President of the State University of New York at Stony Brook, Shirley Strum Kenny has combined a teaching and research career with administrative leadership. Widely recognized for her initiatives to build bridges between the academic and business communities, she has been active in business and education collaboratives on workforce issues. Dr. Kenny has taught at the University of Texas, Gallaudet College, the Catholic University of America, the University of Delaware and the University of Maryland. At Maryland, she was Chair of the English Department and Provost of Arts and Humanities. She became President of Queens College CUNY in 1985 and of Stony Brook in 1994. She serves on a number of boards including Computer Associates International, Toys "R" Us, and the Chase Manhattan Metropolitan Advisory Board. She previously served as Chair of the Folger Shakespeare Library Institute Central Executive Committee, as Chair of the Association of American Colleges and Universities, and as a board member of the Carnegie Foundation for the Advancement of Teaching. Born in Texas, she holds undergraduate degrees from the University of Texas, a master's degree from the University of Minnesota, and a doctorate from the University of Chicago as well as several honorary degrees. Recipient of Woodrow Wilson, Fulbright, National Endowment for the Humanities, and Guggenheim awards, she has published five books and numerous articles on Restoration and eighteenth century British drama.

Robert M. O'Neil

Founding Director of the Thomas Jefferson Center for the Protection of Free Expression, Robert M. O'Neil has been able to fold his vast knowledge of law into the administrative workings of academia. He served as President of the University of Virginia for five years and continues on its law faculty, teaching courses in constitutional and copyright law. After serving as law clerk to Supreme Court Justice William J. Brennan Jr., Dr. O'Neil began his teaching career in 1963 at the University of California Law School at Berkeley. His administrative career was born at the University of Cincinnati where he served as Provost in the early 1970's. He was Vice President of Indiana University at Bloomington and later President of the statewide University of Wisconsin before coming to Virginia. He taught law at each institution. A native of Boston, Dr. O'Neil holds three degrees from Harvard and honorary degrees from Beloit College and Indiana University. He is the author of several books including *Classrooms in the Crossfire* and was General Counsel to the American Association of University Professors from 1970 to 1972 and again from 1990 to 1992.

Carolynn Reid-Wallace

Former U.S. Assistant Secretary of Education, Carolynn Reid-Wallace has served as Senior Vice President, Education and Programming, for the Corporation for Public Broadcasting since 1993. In that role, she carries out the Corporation's commitment to provide and enhance educational services through public telecommunications and evolving technologies. From 1991 to 1993, she directed a staff of 1,250 federal employees and 10 regional offices concerned with the U.S. Department of Education's role in post-secondary education. It was an area close to her heart. As Vice-Chancellor for Academic Affairs at the City University of New York from 1987 to 1991, Dr. Reid-Wallace was chief academic officer of the nation's third largest urban university system. Her university-wide review and redesign of teacher education programs was recognized as a national model by *The New York Times*. Prior to directing a national program to increase the effectiveness of humanities education in America's schools for the National Endowment for the Humanities, Dr. Reid-Wallace held several positions at Bowie State College, Maryland, including the Acting Presidency, and taught at Grinnell College, The George Washington University, Howard University, Washington, and Talladega College. The recipient of a Ph.D. degree in English and American Literature from The George Washington University, she has been a Rockefeller scholar, a Ford fellow, a John Hay Whitney alternate, and a Fulbright lecturer.

Chang-Lin Tien

The first Asian-American to head a major research university in the United States, Chang-Lin Tien became seventh Chancellor of the University of California at Berkeley in 1990. Internationally recognized for his research in the field of heat transfer technology, he is the recipient of many honors including a Guggenheim Fellowship and the Max Jakob Memorial Award, the highest honor in the field of heat transfer. Anchored in both American and Asian cultures, Dr. Tien is deeply committed to maintaining excellence and to broadening the democratic reach of higher education to all groups. Born in China and educated in Shanghai and Taiwan, he came to the United States in 1956 and earned a master's degree at the University of Louisville in 1957. He then earned a second master's and a Ph.D. degree at Princeton in 1959, the same year he joined the Berkeley faculty. A recipient of honorary degrees from several universities, he currently serves on the Board of Trustees at Princeton, the Asia Foundation, and Wells Fargo Bank. He has published more than 280 journal articles, has been editor of three international journals, and has guided more than 60 students to the doctorate.

Chen Ning Yang

Nobel Prize winning physicist, Chen Ning Yang directs the Institute for Theoretical Physics at the State University of New York at Stony Brook, where he also holds the title of Albert Einstein Professor of Physics. Born in China, he received his doctorate from the University of Chicago in 1948 and joined Princeton's Institute for Advanced Study in 1949, where he served as a professor from 1955 until 1966, the year he came to Stony Brook. Dr. Yang is a member of the U.S. Academy of Sciences; the Academia Sinica, Taiwan; and the American Philosophical Society. He also belongs to the Russian Academy of Sciences, the Royal Society, London; and several other academies. In addition to the Nobel Prize, which he won in 1957, Dr. Yang is the recipient of the Rumford Premium, the National Medal of Science, the Benjamin Franklin Medal, the Bower Prize, and the N. Bogoliubov Prize, which he received in 1996. He holds more than a dozen honorary degrees including an honorary Doctor of Science degree from Princeton.